Serial No._____

PRELIMINARY
INSTRUCTION MANUAL

# MODEL 3000
# SIGNAL
# GENERATOR

This preliminary manual is supplied to permit the earliest possible delivery of instruments. A final manual will be supplied when available.

WAVETEK® INDIANA INC.

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# SECTION 1
# GENERAL INFORMATION

## 1.1 INTRODUCTION

The Model 3000 is a rugged, completely solid-state Signal Generator covering the frequency range of 1 to 520 MHz. The output can be amplitude or frequency modulated and the level can be set between +13 and -137 dBm.

### 1.1.1 Frequency Characteristics

The frequency of the unit is set via 6 front panel lever/indicator switches which yield a resolution of 1 kHz. In addition, remote frequency programmability is standard. This feature makes the Model 3000 Signal Generator ideally suited for both semi and fully automatic test applications.

The accuracy of the instrument is based on a crystal-controlled oscillator that serves a stable frequency source for the derivation of various reference frequencies. These reference frequencies are fed to phase locked loops that enable the Model 3000 to provide high stability signals to an accuracy of 0.001% over its specified 1 MHz to 520 MHz range.

In the CW and AM modes of operation the overall accuracy of the unit is 0.001% including short term drift, long term drift, incidental FM and variations due to line voltage changes and temperature changes. In the FM mode, the frequency is accurate to 0.001% ±10 kHz up to 5 kHz peak deviation and 0.001% ±45 kHz up to 500 kHz peak deviation.

### 1.1.2 Modulation Features

The Model 3000 also features both internal and external amplitude and frequency modulation capabilities. Internal modulation frequencies of 400 Hz and 1 kHz are available. In the FM mode of operation, peak deviations up to 500 kHz are attainable. In the AM mode amplitude modulation to 90% is attainable.

With the MODULATION MODE switch in either of the FM positions and the MODULATION FREQUENCY switch in the vernier position, the front panel slide control potentiometer can be used to continuously vary the output frequency over either a 5 kHz or 500 kHz range.

With the MODULATION MODE switch in the AM position and the MODULATION FREQUENCY switch in the vernier position the output amplitude can be varied via the same front panel slide control. This provides a reference attenuator for variation of a signal level around a specific point of interest. This operation can also enable the user to obtain greater than 20 milliwatts of power over portions of the band.

### 1.1.3 Output Level Features

The output power is indicated on a front panel meter calibrated in both dBm and Vrms. A fifteen-position, 10 dB step attenuator used in conjunction with an 11 dB vernier control provides the user with a range of +13 dBm to -137 dBm. The calibrated output of the Model 3000 is leveled to within ±0.75 dB across the complete frequency range of the instrument.

## 1.2 SPECIFICATIONS

### 1.2.1 Frequency

| | |
|---|---|
| RANGE | 1 MHz to 520 MHz selectable in 1 kHz steps. |
| READOUT | 6 digit lever/indicator switches |
| RESOLUTION | 1 kHz |
| ACCURACY | CW and AM modes ±0.001%<br>FMx1 mode ±(0.001% ±10 kHz)<br>FMx100 mode ±(0.001% ±45 kHz) |
| STABILITY | CW and AM modes <0.2 ppm/hr.<br>FM modes 500 Hz/10 min. |

### 1.2.2 RF Output Level

| | |
|---|---|
| POWER LEVEL RANGE | +13 dBm to -137 dBm (1 V to .03 µV) |
| LEVEL CONTROL | Continuously adjustable in 10 dB steps and with an 11 dB vernier. Output level is indicated on a front panel meter calibrated in volts and dBm. |
| TOTAL LEVEL ACCURACY | +13 to -7 dBm ±1.25 dB<br>-7 to -77 dBm ±1.95 dB<br>-77 to -137 dBm ±2.75 dB |
| ACCURACY BREAKDOWN | Flatness (+13 to -7 dBm) ±0.75 dB<br>Output Meter ±0.5 dB<br>Step Attenuator ±0.5 dB to 70 dB<br>(±0.2 dB calibration error)<br>±1.0 dB to 130 dB<br>(±0.5 dB calibration error) |

### 1.2.3 Output Characteristics

| | |
|---|---|
| IMPEDANCE | 50 ohms |
| SWR | <1.2 at RF output levels below 0.1 V |

### 1.2.4 Spectral Purity

| | |
|---|---|
| HARMONIC OUTPUT | >30 dB below fundamental from 10 to 520 MHz<br>>20 dB below fundamental from 1 to 10 MHz |
| SUB-HARMONICS | None detectable |

| | |
|---|---|
| NON-HARMONICS | >70 dB below fundamental from 1 to 200 MHz<br>>60 dB below fundamental from 200 to 350 MHz<br>>35 dB below fundamental from 350 to 520 MHz |
| RESIDUAL AM | >55 dB below carrier (50 Hz to 15 kHz post detection noise bandwidth) |
| RESIDUAL FM | Typically 200 Hz (50 Hz to 15 kHz bandwidth) |

1.2.5 Amplitude Modulation

NOTE: These specifications apply for a carrier level $\leq$+3 dBm. AM is possible above +3 dBm if the peak output does not exceed +13 dBm.

| | |
|---|---|
| FREQUENCY | |
| Internal | 400 Hz and 1 kHz, ±10% |
| External | DC to 20 kHz, input level required = 10 volts p-p into 600 ohm to provide calibrated % modulation control. |
| RANGE | 0 to 90% |
| DISTORTION | 3% distortion to 70% modulation (5% to 90% AM) at a frequency of 1 kHz. |
| MODULATION CONTROL | Calibrated from 0 to 100% |
| ACCURACY | ±(5% Full Scale +5% of reading) |

1.2.6 Frequency Modulation

| | |
|---|---|
| FREQUENCY | |
| Internal | 400 Hz and 1 kHz, ±10% |
| External | DC to 25 kHz, input level required = 10 volts p-p into 600 ohms to provide calibrated deviation control. |
| DEVIATION PEAK | Two bands, 0 to 5 kHz , and 0 to 500 kHz |
| DEVIATION CONTROL | Calibrated from 0 to 5 kHz, X1 and X100 |
| ACCURACY | ±250 Hz on X1 range<br>±35 kHz on X100 range |

1.2.6 Programmability

Frequency is programmable via rear panel input connector using standard 8-4-2-1 BCD contact closures.

### 1.2.8 General

| | |
|---|---|
| OPERATING TEMPERATURE | 25° to 35° C |
| OUTPUT CONNECTOR | Type N |
| RFI | <0.5 μV is induced in a two-turn, one-inch-diameter loop which is held one inch away from any surface. Loop feeds a 50 ohm receiver. |
| POWER | 115/230 V ±10%, 50/60 Hz, 40 VA |
| DIMENSIONS | 12 in. (30.3 cm) wide, 5¼ in. (13.4 cm) high, 13 3/4 in. (34.9 cm) long |
| WEIGHT | 25 lb. (11.4 kg) net, 30 lb. (13.6 kg) shipping |

## 1.3 OPTIONS

| | |
|---|---|
| RF Level Programming | Option "-1" provides remotely programmable level from 0 to 89.9 dB in 0.1 dB steps. |
| Pulse Modulation | Option "-2" allows the instrument to be modulated to provide pulses with a 40 dB on/off ratio. |
| RF Output Protection | Option "-3" is a circuit breaker in the RF output system of the instrument. This prevents damage to the instrument in the event that large RF signals are fed into the signal generator while testing a transceiver. |

## 1.4 ACCESSORIES

| | |
|---|---|
| Furnished with instrument: | Instruction Manual<br>Rear panel remote plug and pins |
| Additional accessories: | Rack Mount Kit |

# SECTION 2
# OPERATION

## 2.1 INTRODUCTION

This section provides complete installation and operating instructions for the Wavetek Model 3000 signal generator. The instructions consist of mechanical installation, electrical installation, front and rear panel features, installation checks and operating procedures.

## 2.2 MECHANICAL INSTALLATION

### 2.2.1 Initial Inspection

After unpacking the instrument, visually inspect the external parts for damage to knobs, connectors, surface areas, etc. The shipping container and packing material should be saved in case it is necessary to reship the unit.

### 2.2.2 Damage Claims

If the instrument is received mechanically damaged in transit, notify the carrier and either the nearest Wavetek area representative or the factory in Indiana.

Retain the shipping carton and packing material for the carrier's inspection.

The local representative, or the factory will immediately arrange for either the replacement or repair of your instrument, without waiting for damage claim settlements.

### 2.2.3 Rack Mounting (K108)

CONTENTS

| Item | Qty | Part No. |
|---|---|---|
| A (Insert) | 2 ea | B001-145 |
| B (Side) | 2 ea | B001-146 |
| C (Screw) | 12 ea | HS101-806 |

Procedure: (See Figure 2-1)

Remove the screws from one side panel. Mount items A and B against the side panel of the instrument and secure with the screws provided (item C). Repeat the operation for the other side of the unit.

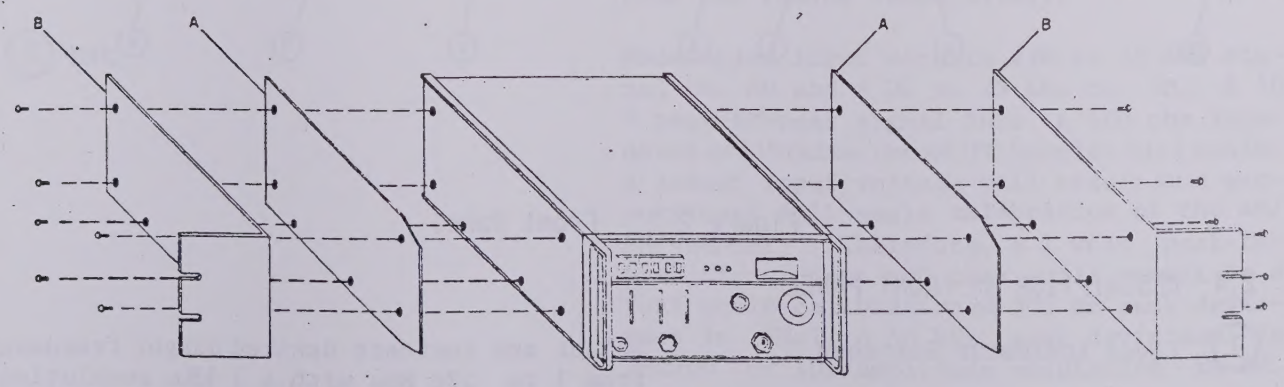



Figure 2-1. K108 Rack Mount

## 2.3 ELECTRICAL INSTALLATION

The instrument operates from either 115 volt AC or 230 volt AC supply mains as selected by a Slide Switch located on the rear panel. Before operating the instrument, check that the fuse mounted in the Rear Panel Fuse Holder corresponds to the correct value for the selected voltage, i.e., 1.0 amp for a 115 volt AC and 0.5 amp for 230 volt AC.

The power supply has been designed to operate from either 50 or 60 Hz supply mains.

Instruments are shipped from the factory for operation at 115 volt AC 60 Hz unless specified for 230 volt AC or 50 Hz operation.

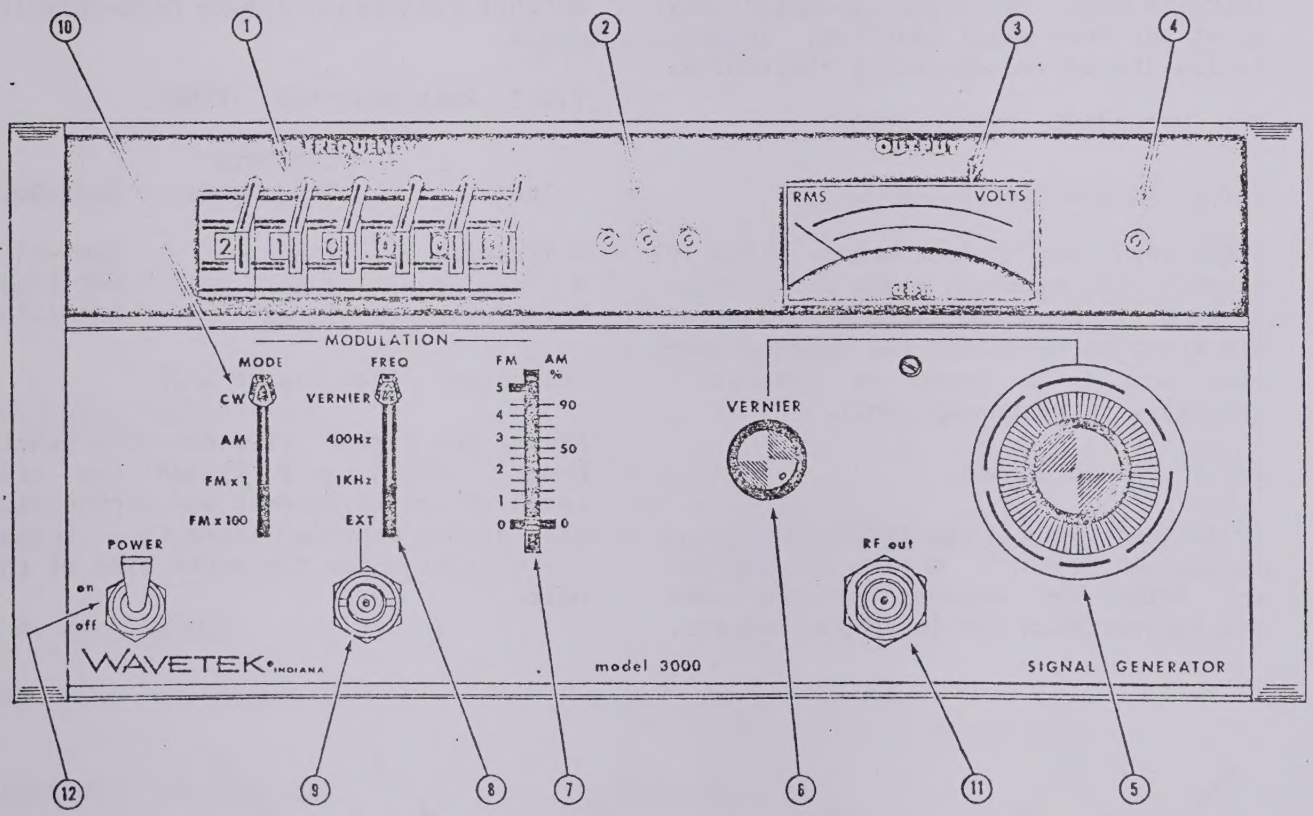



Figure 2-2. Front Panel

## 2.4 DESCRIPTION OF FRONT PANEL

(1) Lever Indicator Switches — Select and indicate desired output frequency from 1 to 520 MHz with a 1 kHz resolution.

| | |
|---|---|
| (2) Accuracy Lamps | Indicate frequency accuracy. ±0.001% in CW and AM modes, ±(0.001% + 10 kHz) in FMx1 and ±(0.001% + 45 kHz) in FMx100. Typically the lamp will flash for a few seconds after power is turned on. Under normal operation a steady light indicates that the unit is phase-locked and the frequency accuracy indication is valid. A continuously flashing light indicates that one or more of the phase lock loops is open. (The open loop can be identified by removing the top cover and looking for the corresponding "module fault" light.) |
| (3) Output Level Meter | Indicates output level over an 11 dB range in VRMS and dBm. |
| (4) Unlevel Lamp | Indicates that the output level accuracy is not valid when the lamp is on. |
| (5) Attenuator | Controls the output level over a 140 dB range from +10 to -130 dBm. The Attenuator dial is calibrated in the dB and VRMS. |
| (6) Vernier | Controls the output level over an 11 dB range. |
| (7) AM/FM Vernier | Is calibrated from 0 to 5 kHz FM peak deviation and from 0 to 90% AM. This control permits precise AM and FM settings with the mode switch in AM and FMx1 or FMx100 respectively and the frequency switch in 400 Hz, 1 kHz or Ext. The vernier also serves as a manual amplitude and frequency control with the frequency switch in vernier. The vernier provides up to +6 dB amplitude change when the mode switch is in the AM and also provides up to a +5 kHz or up to +500 kHz frequency change when the mode switch is in FMx1 and FMx100 respectively. |
| (8) Ext | Modulation input accepts a DC to 20 kHz signal for AM and a DC to 25 kHz for FM. A 10 V peak-to-peak signal into a 600 ohm impedance calibrates the AM/FM vernier full scale. A lesser input voltage will result in a proportional full scale calibration of the AM/FM vernier. Therefore, a 1 volt peak-to-peak signal into 600 ohms will result in a full scale calibration of 500 Hz peak deviation in FMx1, a 50 kHz peak deviation in FMx100 or 10% amplitude modulation in AM. |

(9) Frequency Switch — Selects vernier, for manual amplitude or frequency control, 400 Hz and 1 kHz internal modulation and external modulation.

(10) Mode Switch — Selects CW, AM, FMx1 or FMx100 operation.

(11) RF out — Type N connector provides a connection for the RF output signal.

(12) Power Switch — Provides AC power to the power supply.

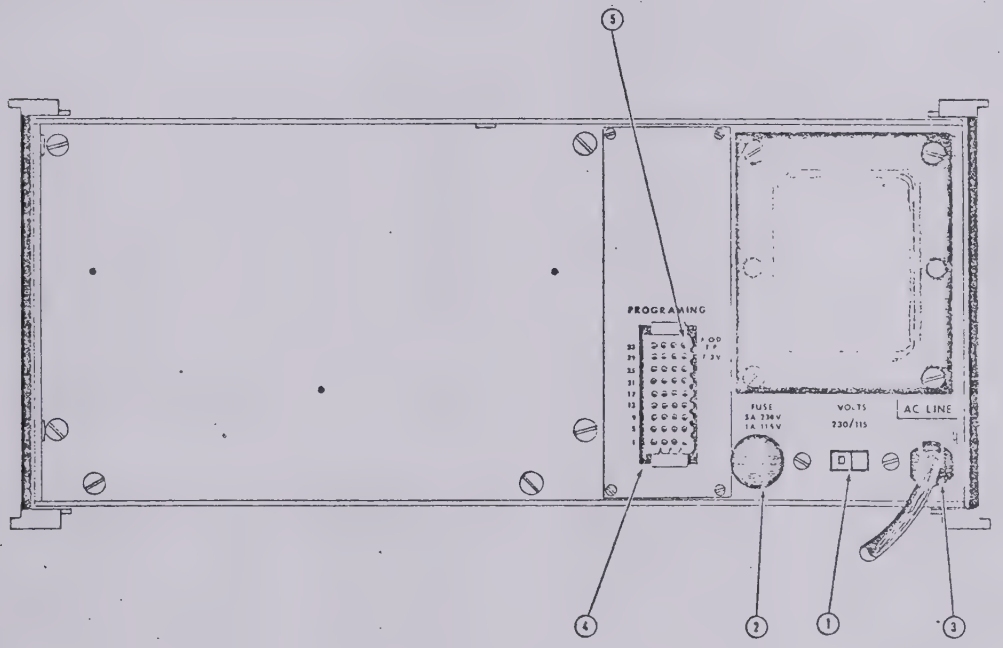



Figure 2-3. Rear Panel

## 2.5 DESCRIPTION OF REAR PANEL

(1) Switch 115/230 V — Selects either 115 volt AC or 230 volt AC supply mains. Before operating the instrument check that the fuse mounted in the Rear Panel Fuse Holder corresponds to the correct value for the selected voltage.

(2) AC Line Fuse — 1.0 amp for 115 volt AC or 0.5 amp for 230 volt AC.

(3) Input 50/60 Hz — 3 prong AC plug provides connection to AC mains.

| | | |
|---|---|---|
| (4) | Remote Jack | Provides connection for programming of frequency. |
| (5) | Modulation Test Point | Monitors internal or external AM or FM modulation. |

## 2.6 INSTALLATION CHECKS

The following procedure is used to determine that the instrument is operating properly. Performance testing and calibration of the instrument is contained in other sections of this manual. If it is determined that the unit is not operating properly or is not meeting specifications, refer to the warranty on the back of the title page.

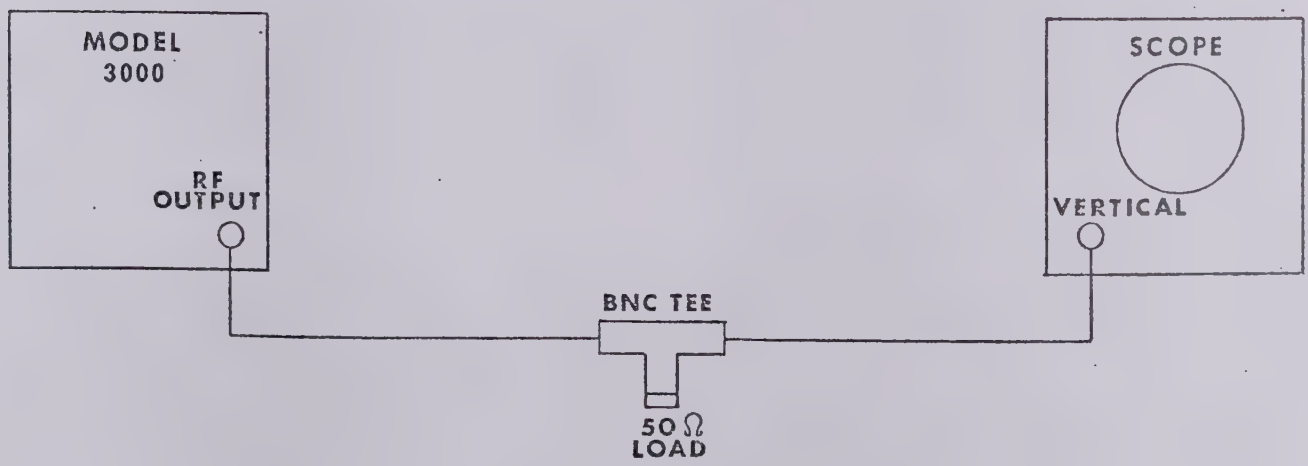
### 2.6.1 Turn On

Verify that the power transformer primary is matched to the line voltage available, and that the proper fuse is installed. (See Section 2.3 Electrical Installation) Turn the front panel power switch to the "ON" position. One or more of the front panel accuracy lights will be illuminated indicating an operating condition. No warmup is needed for the following checks.

### 2.6.2 Control Adjustment

Set the Model 3000 front panel controls as follows:

| | |
|---|---|
| Output Frequency | 10 MHz (Lever indicator switches as follows 010.000). |
| Mode Switch | CW |
| Frequency Switch | 1 kHz |
| AM/FM Vernier | 0 (Down Position) |
| Vernier | Full CW |
| Attenuator | +10 dBm |




NOTE: MUST BE HIGH FREQUENCY OSCILLOSCOPE (GREATER THAN 10 MHz)

Figure 2-4. Test Setup

2.6.3 RF Output Check

Connect the equipment as shown in Figure 2-4. The 10 MHz signal must be at least 2.8 V p-p (a high frequency oscilloscope must be used for these checks).

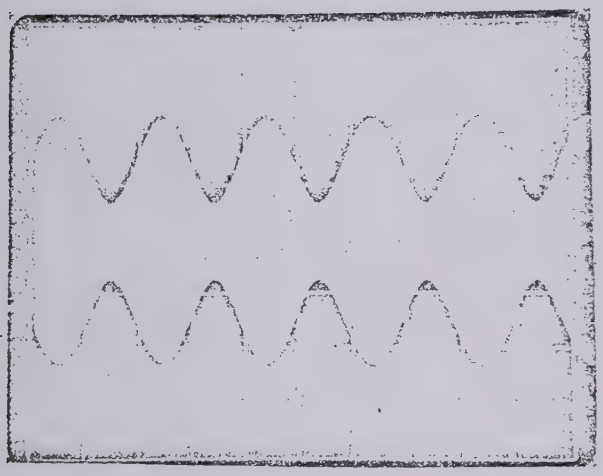


Figure 2-5. AM Modulation

2.6.4 AM Modulation Check (1000 Hz)

Switch the mode switch to AM. Move the AM/FM vernier up to the 50% modulation point. Verify that the AM envelope displayed on the oscilloscope shows a peak-to-valley voltage difference of about 1.4 V and a period of 1 ms. (See Figure 2-5).

2.6.5 AM Modulation Check (400 Hz)

Move the frequency switch to the 400 Hz position. Verify the AM envelope period is 2.5 ms.

2.6.6 FMx1 Check

Switch the mode switch to FMx1. Move the AM/FM Vernier up and down. Verify that the oscilloscope shows an FM display (See Figure 2-6).

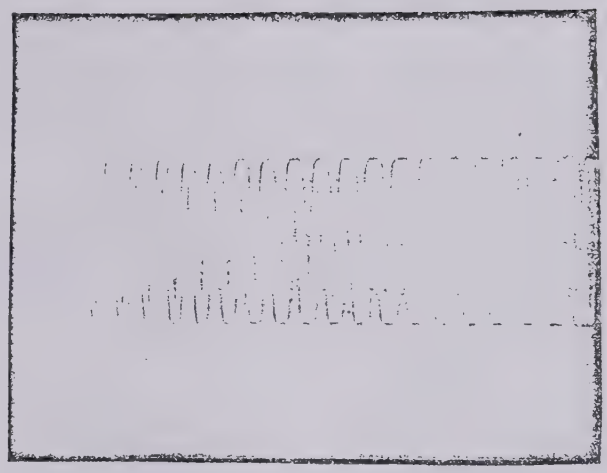


Figure 2-6. FM Modulation

2.6.7 FMx100 Check

Switch the mode switch to FMx100 and repeat the above check.

2.6.8 Frequency Vernier Check

Leaving the mode switch in the FMx100 position place the frequency switch in the Vernier position. Verify that moving the AM/FM Vernier from 0 to 5 kHz shows an increase in frequency on the oscilloscope.

2.6.9 Vernier Output Check

Switch the mode switch to the AM position. Verify that moving the AM/FM Vernier from 0 to 50 shows an increase in output amplitude. (NOTE: The unlevel light may come on during this test.)

2.6.10 Attenuation Check

Switch the mode switch to CW. Verify that the output vernier and attenuator controls change the amplitude of the

signal displayed on the oscilloscope. The instrument is now ready for use.

## 2.7 OPERATING PROCEDURE

No preparation for operation is required beyond completion of the initial installation checks contained in Section 2.6. To insure that the Model 3000 will perform as stated in the specifications, the instrument should have a two hour warmup before using.

### 2.7.1 Turn On

Verify that the power transformer primary is matched to the line voltage available and that the proper fuse is installed (See Section 2.3 Electrical Installation. Turn the front panel switch "ON". One or more front panel accuracy lights will be illuminated indicating an operating condition. NOTE: A flashing indication on the lights indicates an unlocked condition. This should cease in a matter of seconds. If the flashing does not cease, refer to the warranty on the back of the title page. If the unit is not going to be used to the extreme limits of its specifications, it can be used immediately, otherwise a two hour warmup is required.

NOTE: When working with active circuits, transceivers, etc., care should be used to keep voltage or RF power from being applied to the RF output connector. Damage may occur to the output attenuator circuitry of the Model 3000 if this happens.

### 2.7.2 Frequency Selection

Select the frequency desired with the six Lever Indicator switches on the front panel. A frequency between 1 and 520 MHz can be selected with a 1 kHz resolution.

### 2.7.3 Output Level Selection

Set the output attenuator and vernier to the desired level. The output is continuously adjustable over a +13 to -137 dBm range. The level shown on the attenuator added to the meter indication equals the RF output. NOTE: AM modulation is possible at levels above +3 dBm as long as the peak of the modulated output does not exceed the +13 dBm maximum output level. If this level is exceeded the unlevel light will illuminate indicating an unleveled condition.

### 2.7.4 AM Modulation - Internal

Set the mode switch to AM and the frequency switch to either 400 or 1000 Hz modulation rate. Adjust the AM/FM vernier to indicate the desired modulation depth.

### 2.7.5 AM Modulation - External

CAUTION: Input voltages greater than ±10 VDC or 10 VRMS should not be applied to the external modulation input connector or damage may occur to internal circuitry of the Model 3000.

Set the mode switch to AM and the frequency switch to external. Apply a 10 V p-p signal into 600 ohms to the External modulation input connector. This calibrates the AM/FM Vernier control. The desired modulation depth can then be set. The upper frequency limit of this input is 20 kHz.

NOTE: When AM modulating, care must be taken not to exceed the +13 dBm maximum level or excessive distortion and an unlevel condition can exist. In some cases, a high % of AM modulation may cause the unlevel light to come on when the RF vernier control is at minimum. This is caused by the bottoming of the PIN diode leveler which in turn can cause an increase in distortion. If

this is the case, add 10 dB of fixed attenuation and turn the RF vernier control toward maximum. The unlevel light should then go out.

2.7.6 FM Modulation - Internal

Set the mode switch to FMx1 or FMx100 and the frequency to 400 or 1000 MHz. Adjust the AM/FM vernier to the desired peak deviation.

2.7.7 FM Modulation - External

CAUTION: Input voltages greater than ±10 VDC or 10 VRMS should not be applied to the external modulation input connector or damage may occur to internal circuitry of the Model 3000.

Set the mode switch to FMx1 or FMx100 and the frequency switch to external. Apply a 10 V p-p signal into 600 ohms to the external modulation input connector. This calibrates the AM/FM vernier control. The desired peak deviation can be set. For FM modulation the upper frequency limit is 25 kHz.

2.7.8 Vernier Control FM Position

Switch the mode switch to the FMx1 or FMx100 position and the frequency switch to Vernier. Using the AM/FM vernier output control, frequency can be varied in a positive direction up to 5 kHz in the x1 position or 500 kHz in the x100 position.

2.7.9 Vernier Control - AM Position

Switch the mode switch to the AM position and the frequency switch to Vernier. Using the AM/FM vernier control the output amplitude can be varied. It also enables more than 20 mW of power to be obtained over portions of the band.

2.7.10 Programming

Frequency is programmable via a rear panel input connector set by standard 8-4-2-1 BCD contact closures. A mating connector is supplied with each unit. See Figure 2-7 for pin location and identification. These connections are in parallel with the front panel Lever Indicator switches. If the rear panel programming is used, the front panel switches should indicate all zeros. Rear panel BCD programming can be implemented by referring to Table 2-1.

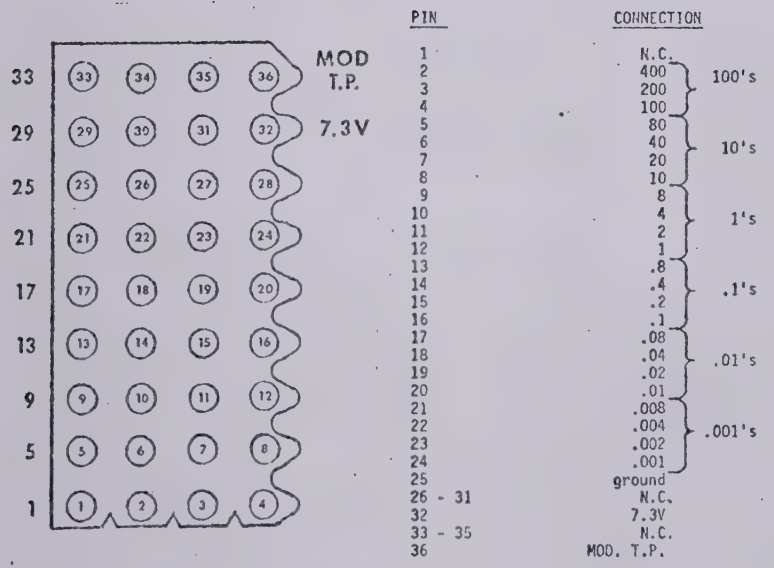



Figure 2-7. Pin Location & Identification

TABLE 2-1.

| | Switch | TTL |
|---|---|---|
| Logic "0" | Open | ≥2.2V |
| Logic "1" | Ground | ≤0.4V |

# SECTION 3
# THEORY OF OPERATION

## 3.1 INTRODUCTION

Section 3.2 presents a block diagram analysis to enable the reader to get a brief overall view of the operation of the instrument. Sections 3.3 - 3.15 contain more detailed descriptions of each subassembly.

For actual wiring of the chassis and subassemblies, refer to the schematics in Section 7 of the manual.

## 3.2 OVERALL BLOCK DIAGRAM

The Model 3000 is essentially a voltage controlled oscillator to which phase-locked loops and a crystal reference have been added for the high frequency resolution.

The discussion will first deal with the basic signal generator then it will describe how the phase-locked loops provide the additional accuracy.

### 3.2.1 Basic Signal Generator

This discussion briefly describes how the RF is generated and how its frequency is controlled, also how the signal is amplified, leveled and amplitude modulated.

Refer to Figure 3-1 for a block diagram of the basic signal generator without phase locking.

RF GENERATION

The RF output frequency is generated by two UHF oscillators and a mixer. The outputs of the two oscillators are heterodyned in the mixer. The difference frequency is amplified and fed to the output amplifier.

The frequencies of these oscillators are controlled by DC voltages applied to their varactor diodes. The Narrow Oscillator yields a single frequency. The Wide Oscillator can be programmed over a range from the frequency of the Narrow Oscillator to 520 MHz above the Narrow frequency.

RF FREQUENCY CONTROL

The RF output frequency is determined by programming the frequency of the Wide Oscillator. The Wide Oscillator is ultimately controlled by the front panel FREQUENCY switches. The BCD output of these switches is converted to an analog voltage which programs the oscillator in 1 MHz steps. This analog signal can provide approximately 3 MHz accuracy.

RF AMPLIFICATION AND LEVELING

THe RF power is amplified by a multi-stage, wide-band amplifier. The flat output is maintained by a closed-loop leveling system around this Output Amplifier.

The Leveler includes a Monitor Diode, an Error Amplifier and a Voltage Variable Attenuator. The Monitor detects the peak of the output of the Output Amp. This detected level is compared to a DC reference by the Error Amp. The output of the Error Amp is fed to a PIN diode (voltage variable) attenuator, which changes the input level to the Output Amp until the monitored signal produces a DC level equal to the reference level.

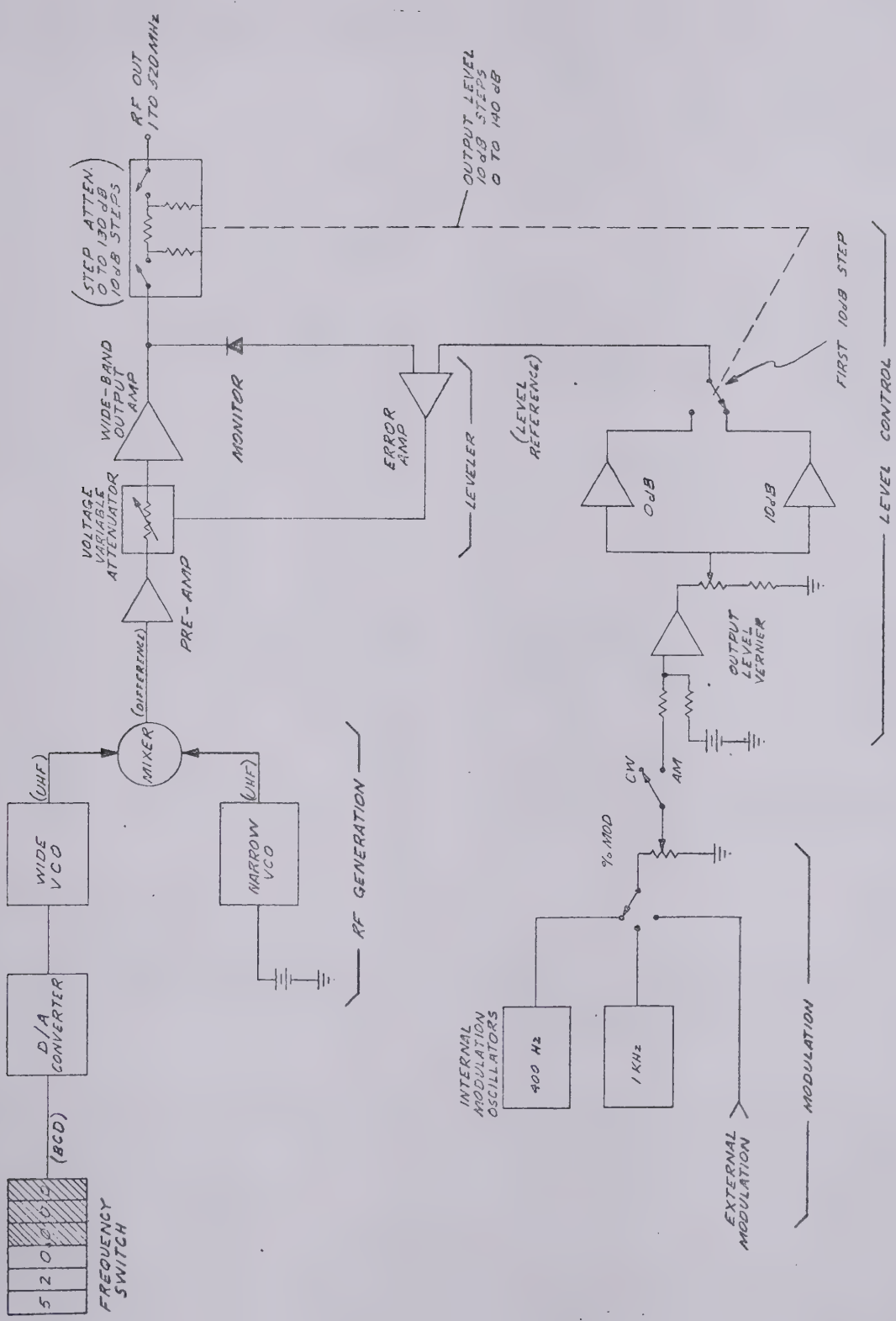



Figure 3-1. Basic Signal Generator

LEVEL CONTROL AND AM

The circuitry for controlling the RF output level is directly related to the above leveling system because changing the DC level reference changes the RF output level.

Of the 150 dB output range, 130 dB is passive attenuation. The remaining 20 dB is controlled by changing the level reference. The VERNIER output control has a 10 dB range. The remaining 10 dB is provided by switching the level reference range. This range switch is provided so that when AM is not required the output amp can provide a carrier at the highest possible power.

Since the RF level can be voltage controlled, AM can be accomplished by applying the modulating signal to the VERNIER level control. This causes the reference voltage to the Error Amp to change at the frequency of the modulating signal. The modulating signal is from one of two internal oscillators or from an external source.

3.2.2 Phase-Locked Loops

The basic signal generator discussed in Section 3.2.1 has a frequency range of 1 to 520 MHz, has an output which is leveled and adjustable and has the ability to be amplitude modulated. With the above circuitry, however, the accuracy is only 3 MHz with 1 MHz resolution. To achieve the desired 1 kHz resolution and .001% accuracy, the instrument includes four phase-locked loops.

Phase-locked loops (PLL) #1, #2 and #4 are used to stabilize the Wide Oscillator and tune it in 1 kHz steps. See Figure 3-1. The Narrow Oscillator is included in PLL #3 which provides stabilization and allows FM operation.

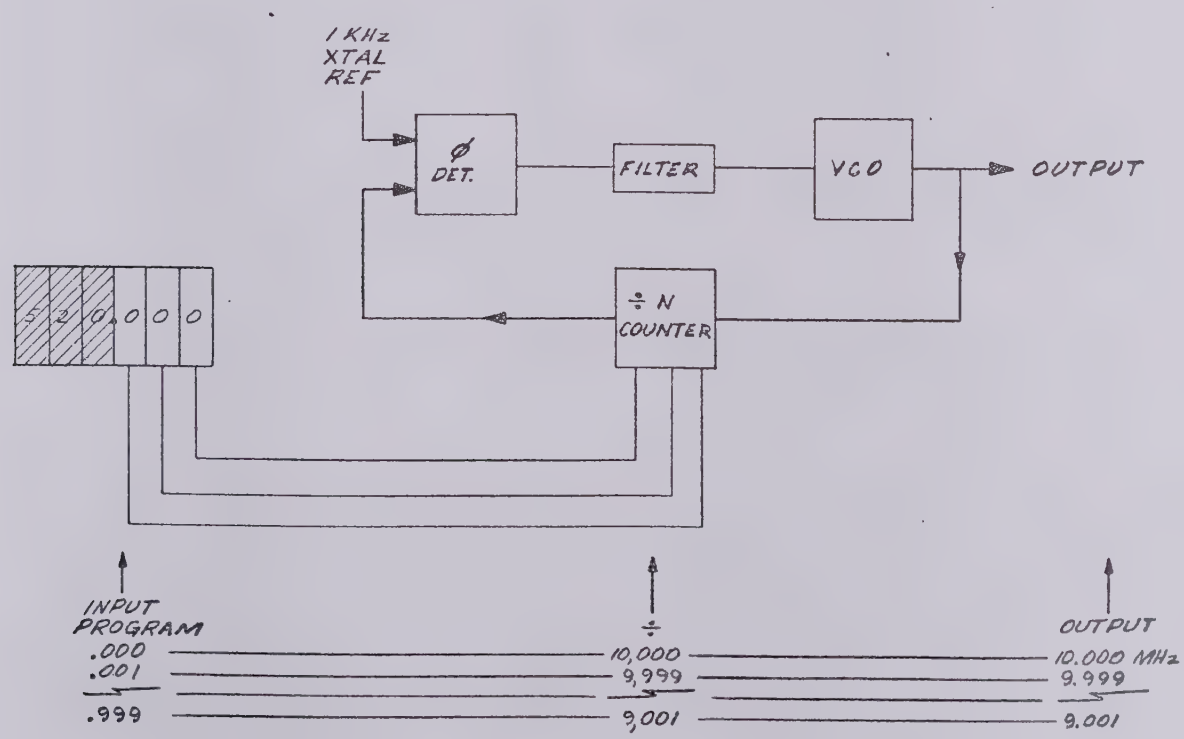



Figure 3-2. PLL #1

PLL #1

The purpose of PLL #1 is to generate a CW signal which changes in 1 kHz steps from 10.000 to 9.001 MHz as the front panel frequency selector is switched from .000 MHz to .999 MHz. This signal will be used as a reference signal for PLL #4.

Figure 3-2 shows a simplified block diagram of PLL #1. It consists of a voltage controlled oscillator capable of frequencies from 9 to 10 MHz, a phase detector and a ÷N counter. A sample of the output signal from the VCO is fed to a programmable counter. The divisor of the counter is controlled by the three front panel kHz selector switches. The output from the counter is fed to a phase detector where it is compared to a 1 kHz crystal reference signal. If the two input signals to the phase detector are not the same frequency, an error signal is produced. This error voltage corrects the frequency of the VCO until the phase detector input from the counter is exactly 1 kHz.

PLL #2

The purpose of PLL #2 is to generate a CW signal which changes in 1 MHz steps from 1448 to 1487 MHz when the front panel frequency selector is switched from 000. to 039. MHz. These CW steps are then repeated every 40 MHz throughout the entire 0 to 520 MHz range. Use of this signal to control the Wide Oscillator will be discussed in the description of PLL #4.

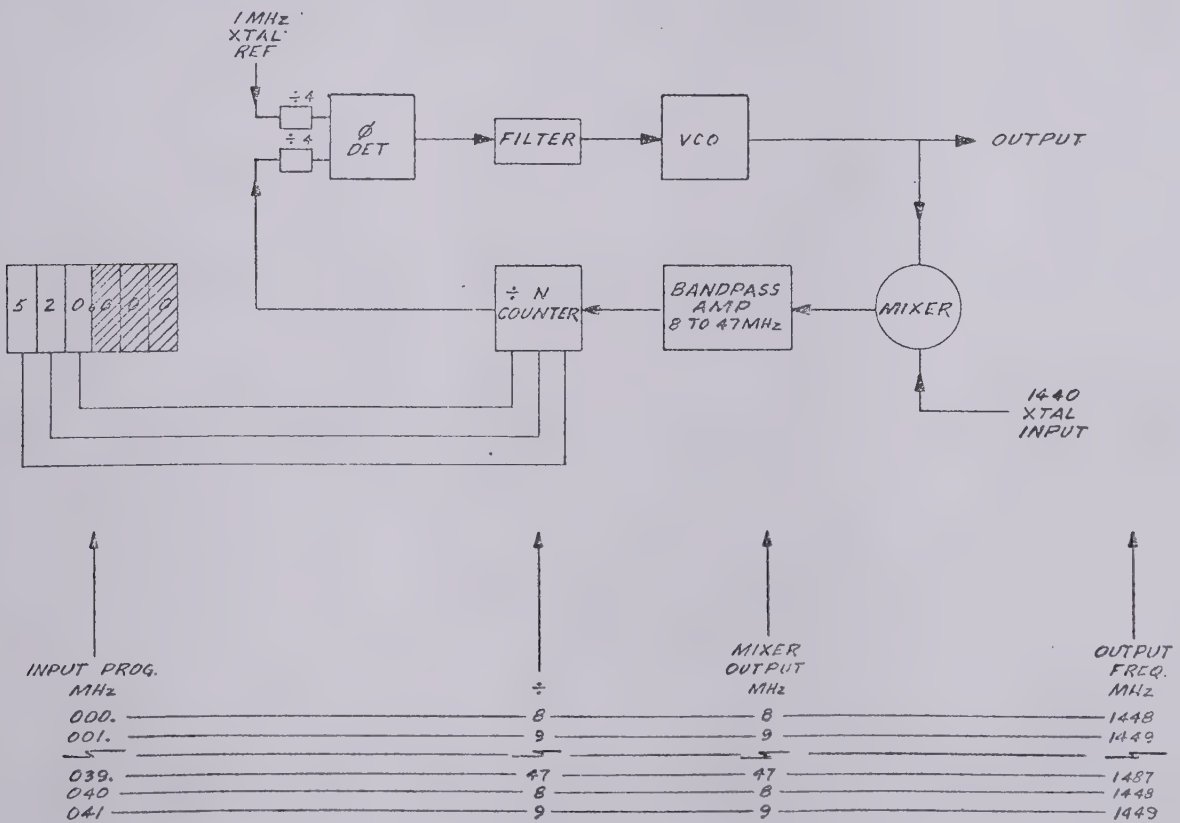



Figure 3-3. PLL #2

Figure 3-3 shows a simplified block diagram of PLL #2. PLL #2 operates in the same manner as PLL #1 with one exception. The circuit includes a mixer and band-pass amplifier. The purpose of this additional circuit is to offset the 1448 to 1487 MHz output from the VCO to 8 to 47 MHz. This offset is necessary in order to make the frequency compatible with the programmable counter and phase detector circuits. The other circuits in this loop operate the same as those in PLL #1. In this case the programmable counter is controlled by the three "MHz" selector switches and the loop reference frequency is 1 MHz.

PLL #4

The purpose of PLL #4 is to adjust the Wide Oscillator in 1 kHz steps from 1198 MHz to 1718 MHz as the front panel frequency selector is adjusted from 0 to 520.000.

The Wide Oscillator frequency is offset by Mixers #1 and #2 and compared to the reference (from PLL #1) by the phase detector. A difference in phase or frequency causes an error signal to tune the Wide Oscillator until both phase detector inputs are identical. How this loop locks on a particular frequency can best be explained in three steps: 1) phase locking at 40 MHz intervals across the band, 2) phase locking at 1 MHz intervals, 3) phase locking at 1 kHz intervals. Figure 3-4 is a simplified block diagram of PLL #4.

To understand locking at 40 MHz intervals, assume temporarily that the reference frequencies from PLL #1 and PLL #2 are fixed (10 MHz and 1448 MHz respectively). Figure 3-5 shows the frequencies throughout the loop for this discussion. This step of the PLL #4 explanation can be described more clearly by considering the entire Wide Oscillator range rather than discussing single frequencies. The Wide Oscillator covers the range of 1198 to 1718 MHz as the Output frequency changes from 0 to 520 MHz. (Figure 3-5, lines A and C.)

When the Wide Oscillator range is heterodyned in Mixer #1 with 1448 MHz the difference frequency which is produced ranges from 250 to 0 to 270 MHz. (Figure 3-5, line E.) This signal is then mixed with a 40 MHz comb (all harmonics of 40 MHz) in Mixer #2. (Figure 3-5, line F.) Taking the difference between line E and F yields the repetitive frequency range from 0 to 20 to 0 MHz as shown in line G. This signal is fed to the phase detector.

The reference to the phase detector is 10 MHz but the loop will not lock on every 10 MHz output of Mixer #2 shown on line G. Only the 10 MHz signals to the immediate right of the 20 MHz signals on the graph are the proper phase to produce lock. Therefore at every 40 MHz interval of the output frequency an input to the phase detector would allow the loop to lock. Section 3.2.1 explains that an analog signal drives the Wide Oscillator to within three MHz of the proper frequency. Therefore, although there are 14 possible lock points on line G, the only one selected will correspond to the analog-tuned frequency of the Wide Oscillator. The unit as described so far is capable of phase locked output at 0, 40, 80. . . 520 MHz. The following is an explanation of locking at 1 MHz intervals.

To allow phase locking at 1 MHz intervals, the reference frequency to Mixer #1 is made adjustable in 1 MHz steps over a 40 MHz range (1448-1487 MHz).

If, for example, this reference frequency to Mixer #1 were 1449 MHz, the input range to the phase detector would look the same except the entire range would be shifted 1 MHz to the right. Lock points would then be possible at output frequencies of 1, 41, 81 MHz, etc.

Being able to change this reference in 1 MHz steps allows phase locking from 0 to 520 MHz in 1 MHz steps.

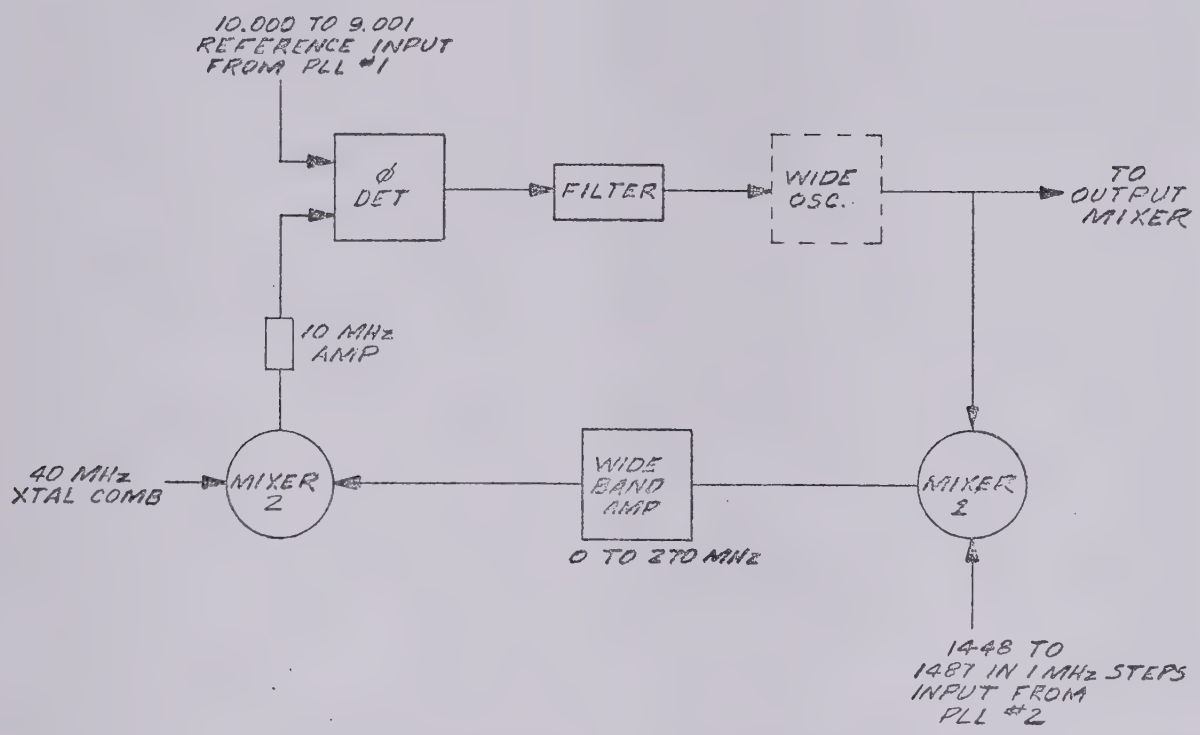



Figure 3-4. PLL #4

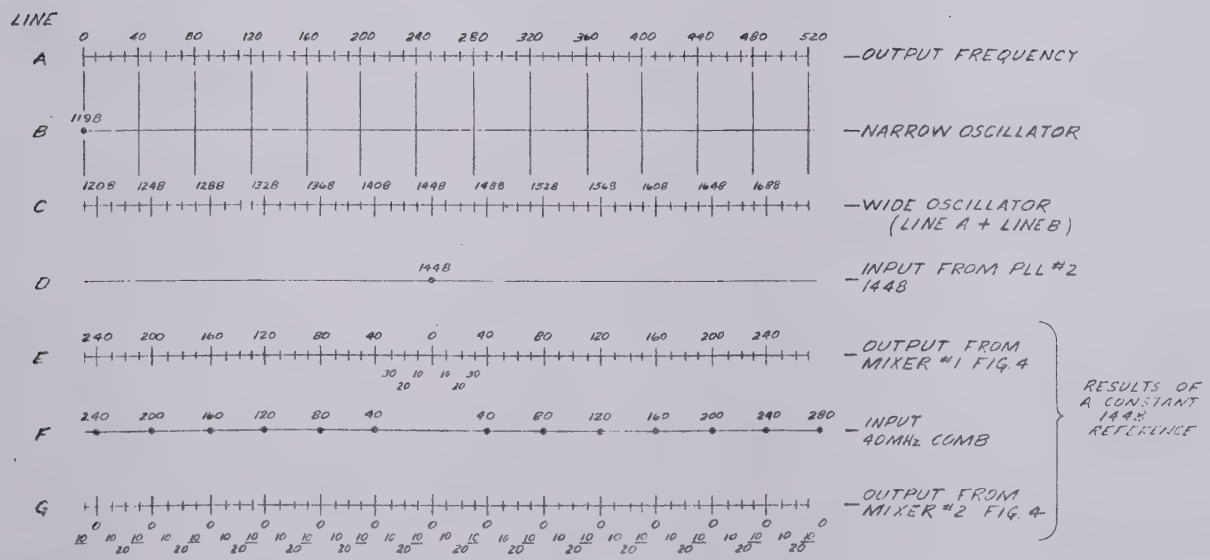



Figure 3-5. PLL #4 Frequencies

To provide phase locking in 1 kHz steps, the PLL #4 phase detector's reference from PLL #1 is adjustable in 1 kHz steps (10.000 to 9.001 MHz). This causes the Wide Oscillator frequency to change in 1 kHz steps in order to keep the loop locked.

PLL #3

The purpose of PLL #3 is to stabilize the Narrow Oscillator at a frequency of 1198 MHz.

Figure 3-6 shows a simplified block diagram of PLL #3. This loop operates in the same manner as PLL #1 and PLL #2 except that it does not require the use of a programmable counter. The 1198 MHz output from the Narrow Oscillator is combined in a mixer with a 1200 MHz crystal controlled signal. This produces a 2 MHz difference signal. This signal is fed to a phase detector where it is compared to a 2 MHz crystal reference. Any difference in the input signals will produce an error voltage which is applied to the Narrow Oscillator (VCO) to correct the frequency error.

To provide FM modulation, the 2 MHz crystal reference applied to the phase-detector in PLL #3 is replaced with the output of a VCO as shown in Figure 3-7.

With a 0 volt (0 deviation) input to the VCO of Figure 3-7, the output is 2 MHz, therefore the operation of the generator is unchanged except the frequency accuracy is reduced because the reference is not now crystal controlled. A modulating signal of +5 V to -5 V will cause the VCO frequency to shift 0.5 MHz above and below the 2 MHz signal. Since the instrument's RF output signal is phase locked to this reference the output of the generator will be FM modulated with a maximum deviation of .5 MHz.

CRYSTAL REFERENCE

All the reference frequencies for the phase-locked loops are derived from a single 40 MHz crystal source by means of appropriate multiplication or division.

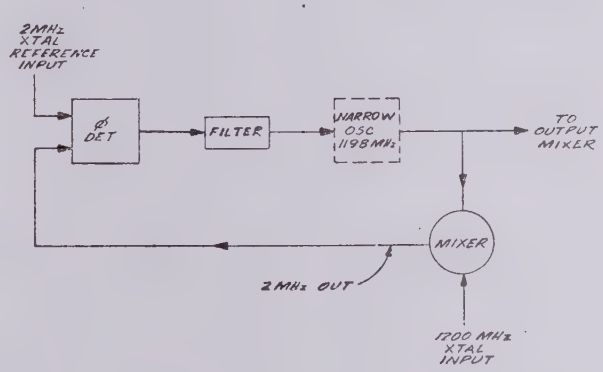



Figure 3-6. PLL #3

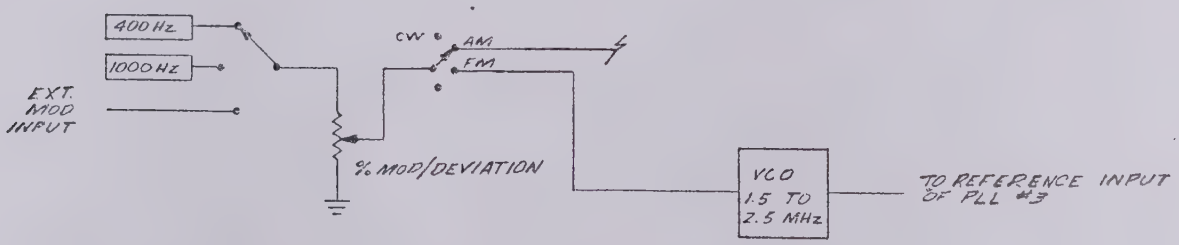



Figure 3-7. FM Circuit

### 3.2.3 Subassembly Descriptions

The overall block diagram discussed in this section describes basically how the instrument functions as a unit. The unit is made up of ten module assemblies and three printed circuit card assemblies. These can be identified in Figure 5-6. Sections 3.3 thru 3.15 describe the operation of each subassembly. The name of the subassembly describes, to an extent, the primary function it performs.

## 3.3 C315 - METER BOARD

The primary function of this assembly is to provide the program voltage to the leveler circuit for the RF amplifier. It also includes the RF output level meter which appears through the instrument front panel. See Figure 3-8.

### 3.3.1 Level Program

During CW operation of the instrument, the level program is controlled by the VERNIER on the front panel. The output of this control goes to two range calibration circuits, "High" and "Low". The range calibration circuits convert the voltage from the VERNIER to a voltage level appropriate to drive the leveler circuit in the M10W.

The "Low" circuit provides the program for all ranges of the detented power output dial except +10 dBm. At "+10" the level program is taken from the "High" circuit. The "High" level program enables the full gain capabilities of the M10W to be used when the output is not amplitude modulated.

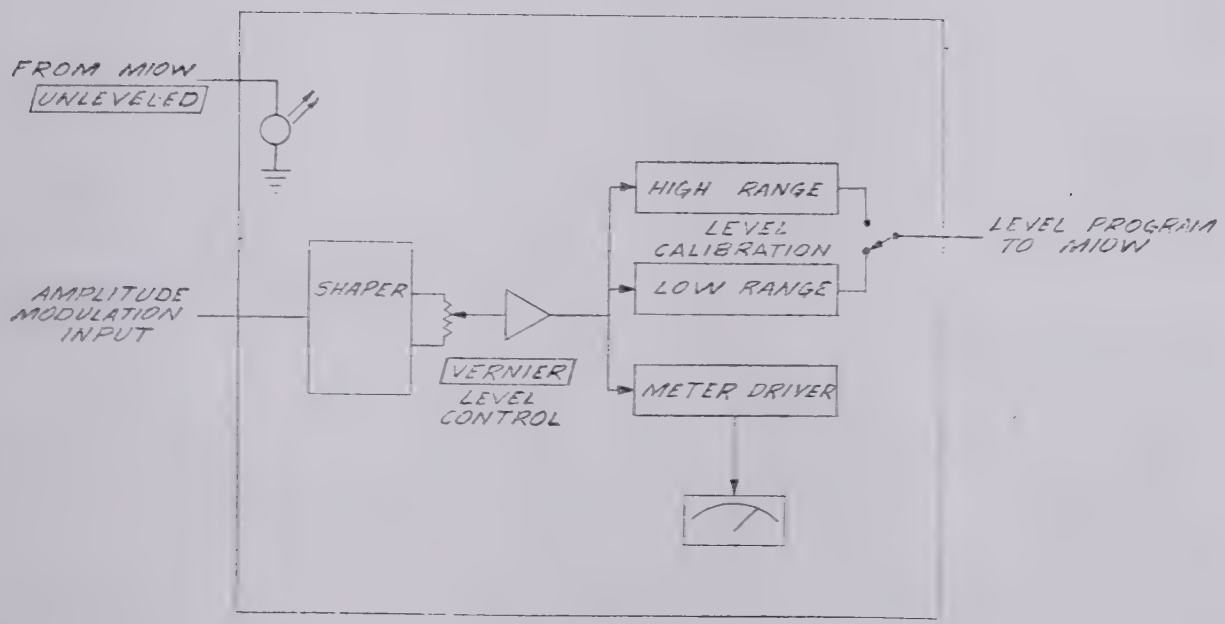



Figure 3-8. C315 - Meter Board

### 3.3.2 Modulation

The modulating signal from assembly C316 is applied to the vernier which ultimately causes the RF level to change. The leveler in the M10W does not cause the RF level to respond linearily to changes in the level program voltage. To compensate for this, a stage is included in C316 to shape the modulation signal before being applied to the vernier.

### 3.3.3 Meter

The output level meter (front panel) is controlled by the level program from the VERNIER. The meter and its driver circuit are designed to display a reading which corresponds to the actual RF level from the M10W.

### 3.3.4 "Unleveled" Light

A light emitting diode is mounted on this assembly and appears on the front panel of the instrument. Refer to the M10W description for an explanation of the circuit driving this light.

## 3.4 C316 - MODULATION BOARD

This assembly provides the modulating signals used in the AM and FM modes. The front panel ACCURACY lights and associated circuitry are also on this assembly. See Figure 3-9.

### 3.4.1 Modulating Signals

The AM or FM modes are achieved by simply routing essentially the same signal to the appropriate circuitry by means of the front panel MODE switch.

The front panel MODULATION FREQ switch selects one of four sources of modulating frequency, one external and three internal. The internal signal can be selected from one of two CW oscillators or a manually variable DC control.

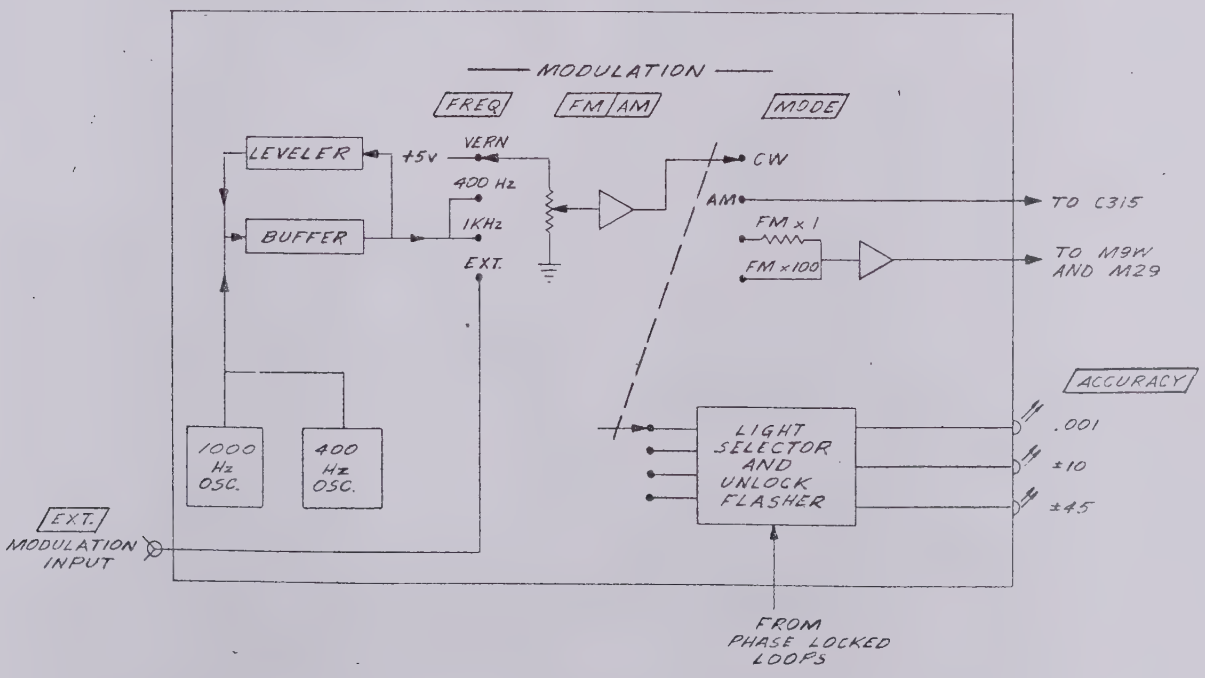



Figure 3-9. C316 Modulation Board

The two internal oscillators are amplified/leveled by the same circuit for simplicity but separately energized by the FREQ switch. The oscillators are twin T oscillators, one is at 400 Hz the other is at 1 kHz.

3.4.2 Accuracy Lights

Which LEDs are lit is determined by the MODE switch. If any of the phase locked loops unlock, the energized LEDs are made to flash by an IC timer which is activated by a DC level from any of the four phase locked loops in the instrument.

## 3.5 DPS-1 - POWER SUPPLY

The DPS-1 provides DC power for the rest of the instrument. See Figure 3-10.

3.5.1 Transformer & Filters

The transformer steps down the line voltage to appropriate levels for the three circuits. Full wave rectifiers and filter capacitors convert this voltage to DC.

3.5.2 +18 V Supply

The +18 V circuit has a zener diode pre-regulator. This feeds a high accuracy, highly stable, IC voltage regulator. The +18 V supply includes current limiting.

3.5.3 -18 V Supply

This circuit compares the +18 and -18 volt outputs and holds the difference in their magnitudes to zero. A circuit is also included to limit the current output of the -18 V supply.

3.5.4 +7.3 V Supply

This circuit is another comparator circuit referenced to the +18 V supply. It is a pre-regulator which supplies other voltage regulators throughout the instrument.

## 3.6 M2M - SWEEP DRIVE

Figure 3-11 shows the block diagram of the M2M circuit.

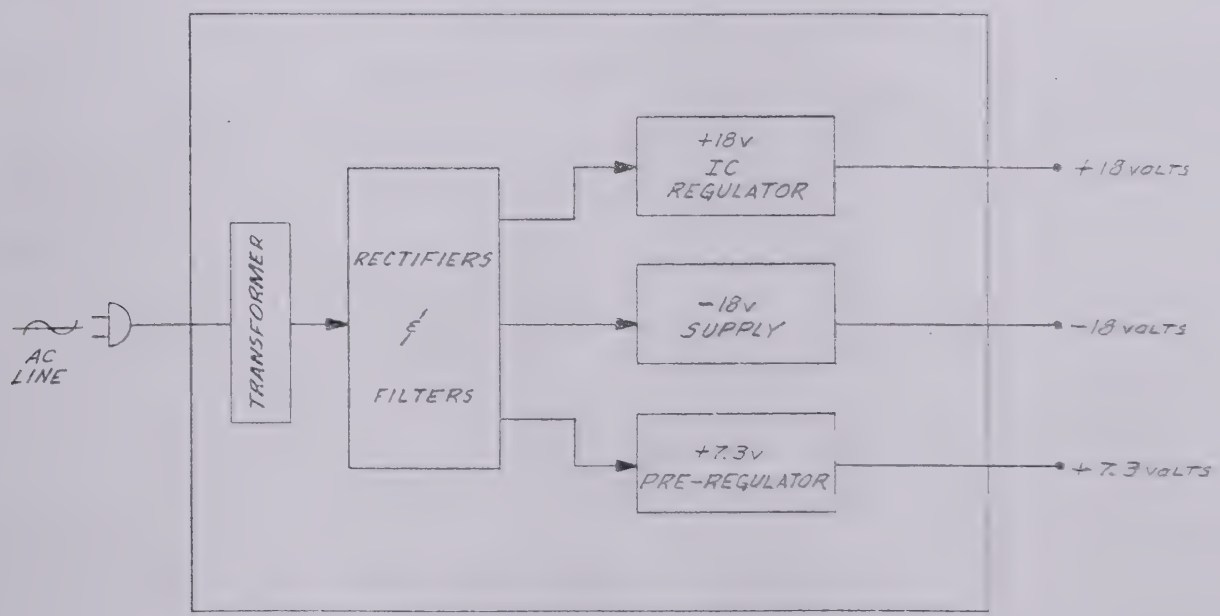



Figure 3-10. DPS-1 - Power Supply

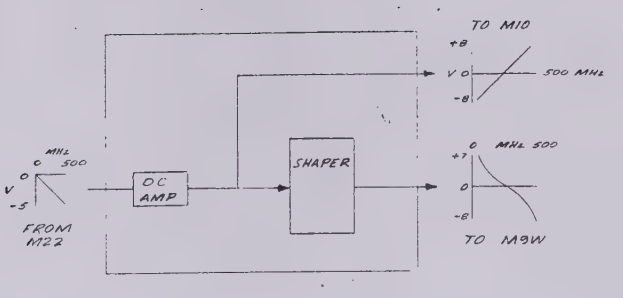



Figure 3-11. M2M Sweep Drive

The analog tuning signal from the M22 is "shaped" before driving the M9W wide oscillator. This module also provides the varactor drive voltage to the M10W tracking filter.

3.6.1 DC Amp

This circuit inverts and slightly amplifies the input voltage for use by the M10W and the M2M shaper circuit. The graphs on the block diagram show the voltages at the input and outputs of the M2M over the range of instrument output frequencies.

3.6.2 Shaper Circuit

This is an inverting DC amplifier which amplifies the input by a smaller factor for smaller magnitude inputs.

Shaping this analog voltage compensates for the nonlinear change in capacitance of the varactor diodes in the M9W oscillator circuit.

3.7 M9W - SWEEP OSCILLATOR

The M9W is the origin of the instrument's RF output frequency. This frequency is generated by heterodyning the signals from two higher frequency voltage controlled oscillators. See Figure 3-12.

3.7.1 Mixer

The narrow oscillator applies a signal of 1198 MHz to the mixer (except in the FM mode). The wide oscillator provides between 1199 and 1718 MHz. The difference (1-520 MHz) is applied to a wide band pre-amp and then sent to the M10W.

3.7.2 Wide Oscillator

The wide range of oscillation is achieved by applying to varactor diodes in the tank circuit an analog signal which is dependent upon the setting of the frequency switches on the instrument's front panel. An additional signal is applied to this VCO from the phase detector in the M34. This is the fine tuning signal which locks the wide oscillator on the proper frequency.

3.7.3 Narrow Oscillator

This oscillator also uses a varactor diode so that the frequency can be voltage controlled for phase locking and for FM operation.

The coarse modulating signal (FM) is applied to the varactor from the modulation board (C316). The frequency of this oscillator is accurately controlled by a "fine tuning" bias voltage from the M33 phase detector. The deviation can be controlled up to 500 kHz.

3.7.4 Levelers

This module contains three RF leveling circuits as shown in the diagram. These maintain a constant amplitude RF over the frequency range and with temperature variation. The output of a peak detector is compared to a constant DC level. Any error is amplified and applied to a PIN diode attenuator in series with the RF signal.

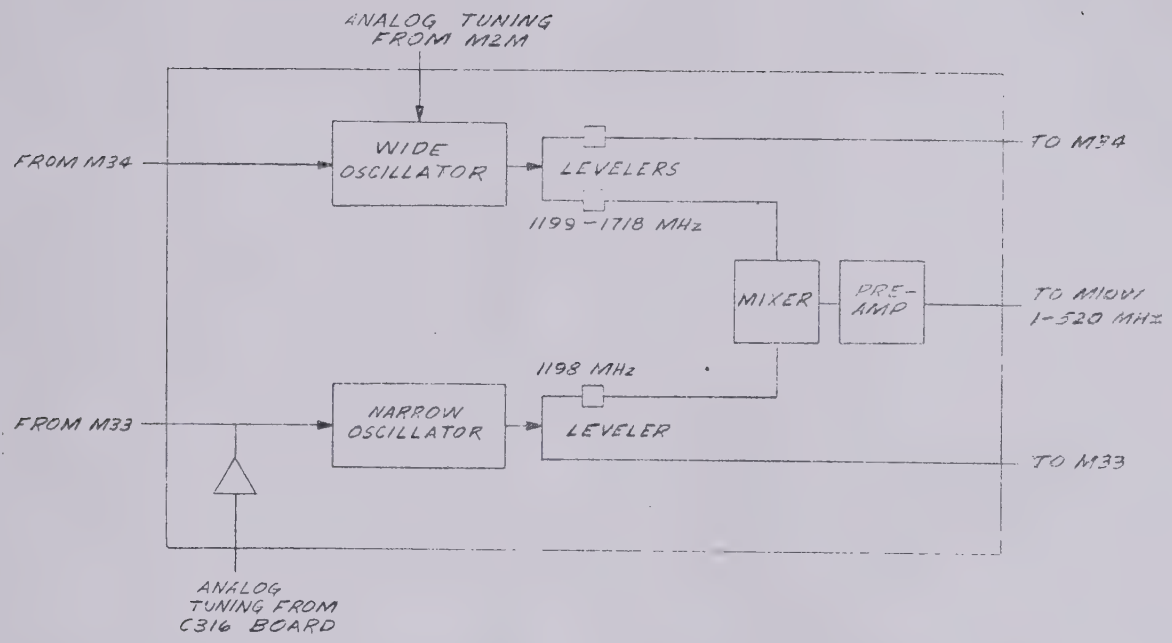



Figure 3-12. M9W Sweep Oscillator

## 3.8 M10W - OUTPUT AMPLIFIER

The main function of the M10W module is to amplify the RF signal from the M9W to a level programmable between -7 and +13 dBm. A leveler circuit maintains a constant amplitude output signal over the wide frequency range. The Unleveled light driver causes the front panel light to glow when the leveler circuit exceeds its proper operating range. See Figure 3-13.

### 3.8.1 Amplifier

This section is a six transistor, wide band amplifier which can increase the RF by about 23 dB. The analog signal from the M2M is applied to the tracking filter varactor diodes in the output of the amplifier section.

### 3.8.2 Leveler

The leveler uses a peak detector, differential amplifier and a PIN diode attenuator. The peak detector is fed from the RF output. The resulting level is compared to a DC (or AM) reference by the differential amp which supplies the control current to the PIN diode attenuator. If the detector RF output deviates from the reference level, the signal to the PIN diode causes the input to be decreased or increased.

In addition to providing a flat frequency response, the leveler allows for electronic control of the RF output amplitude by varying the DC reference. The reference comes from the meter board (C315).

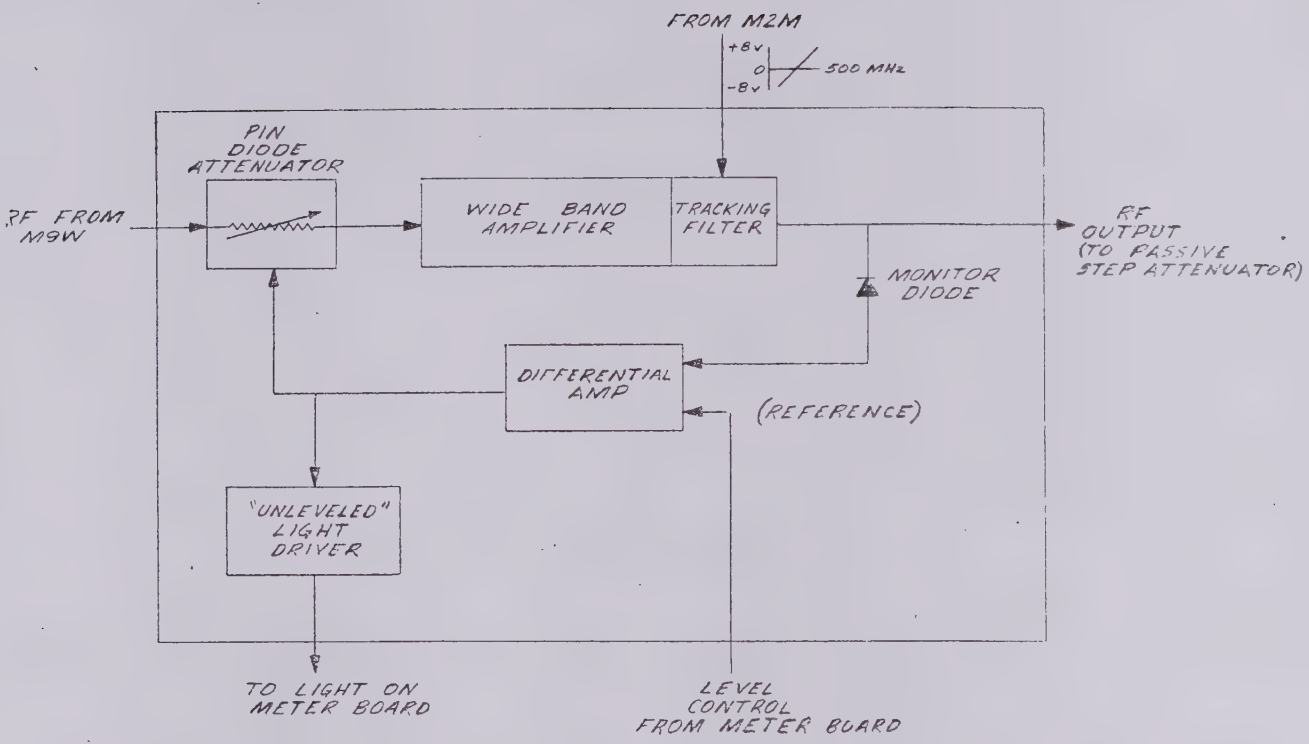



Figure 3-13. M10W - Output Amplifier

### 3.8.3 "Unleveled" Light Driver

When the differential amp in the leveler circuit is putting out a voltage which would cause the PIN diode attenuator to be at its high or low resistance limit, the leveling circuit can no longer be effective. The above voltage levels, which are applied to the unlevel light driver, are adequate to turn on a source of current for the indicator which appears through the front panel.

## 3.9 M22 - DIGITAL TO ANALOG CONVERTER

This module provides two analog outputs which correspond to the frequencies selected by the "MHz" switches (left of decimal point) on the instrument's front panel. One output has a linear voltage versus frequency curve. The other output is linear from 0 to 39 MHz but repeats the analog voltages every 40 MHz. See Figure 3-14.

### 3.9.1 Linear D/A

The front panel "MHz" switches have BCD output which indicates the desired frequency to the M22. For every logic "1" that is present a current is applied to the summing amp. The more significant the activated digit, the more current results. For example, the 4's line (when activated) supplies twice the current of the activated 2's line. The eleven current sources are connected to the summing amp which produces the analog voltage which represents the sum if its "weighted" inputs.

### 3.9.2 Repeating D/A

A summing amp with weighted inputs performs like the one above. The summing amp converts the weighted currents into a corresponding voltage output. The repetition of the output is achieved by using the five least significant BCD

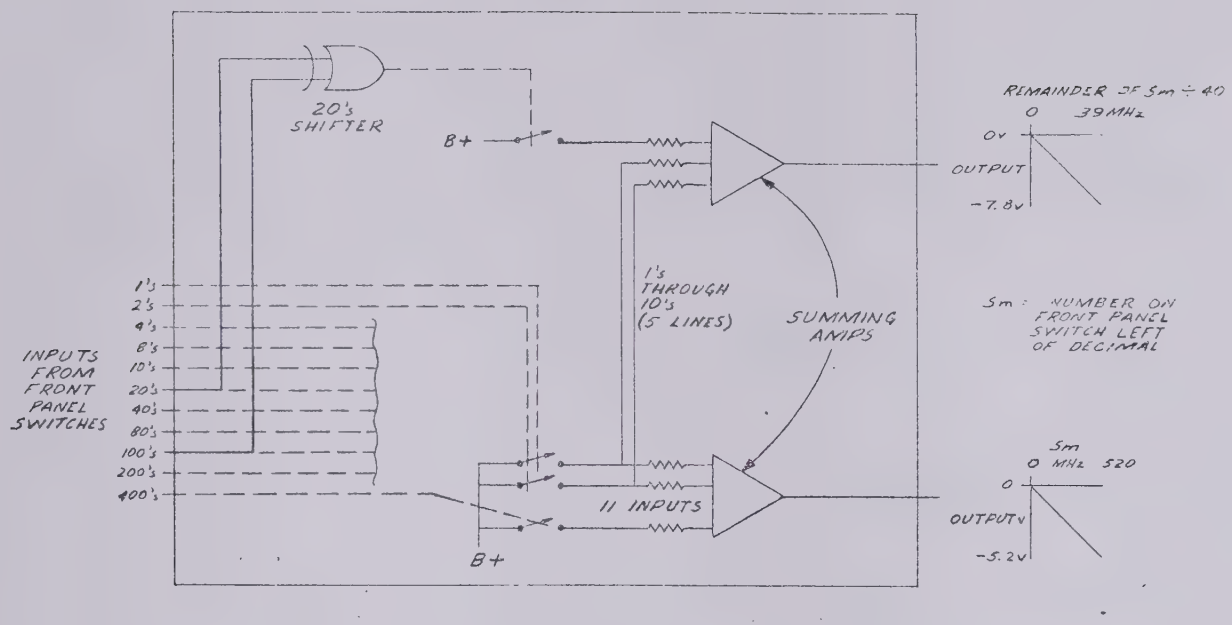



Figure 3-14. M22 - Digital to Analog Converter

lines and an artificial 20's line. These six inputs repeat themselves every 40 MHz as the front panel switches are changed in 1 MHz steps from 1-520 MHz. A 20's line is necessary in order to represent inputs from 20 to 39, but the original 20's line doesn't repeat its sequence with every 40 MHz change in programmed frequency. See Table 3-1. Inverting the 20's line whenever the 100's line is activated causes the 6 inputs to repeat every 40 MHz.

## 3.10 M29 - FM REFERENCE

The M29 is a voltage to frequency converter, the output of which is used as a phase lock reference in the M33. The module includes a voltage variable current source which feeds (determines the frequency of) a square wave oscillator. (See Figure 3-15.) Zero volts in yields 2 MHz out.

TABLE 3-1. 20's CONVERSION

| "MHz" Switch Setting | Original 20's Line | Artificial 20's Line |
|---|---|---|
| 0 | 0 | 0 |
| 20 | 1 | 1 |
| 40 | 0 | 0 |
| 60 | 1 | 1 |
| 80 | 0 | 0 |
| 100 | 0 | 1 |
| 120 | 1 | 0 |
| 140 | 0 | 1 |
| 160 | 1 | 0 |
| 180 | 0 | 1 |
| 200 | 0 | 0 |
| . . . | | |

### 3.10.1 Current Sources

This circuit provides both a positive and a negative source of current. The

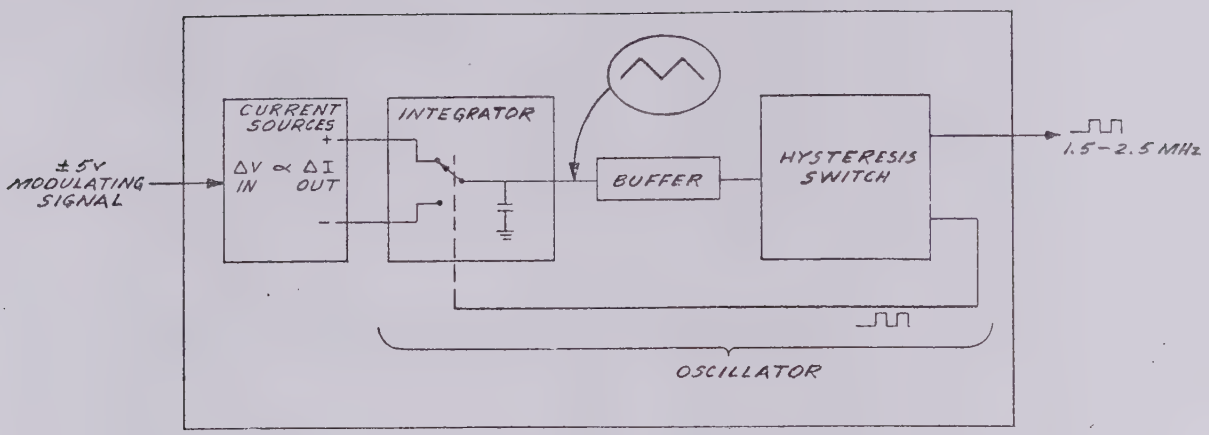



Figure 3-15. M29 - FM Reference

positive source is referenced to the negative source so that the instantaneous currents in both sources are equal.

The change in output current is directly proportional to the change in input voltage to the circuit. The input voltage may vary between -5 and +5 volts. The circuit is designed for a very linear current-out vs. voltage-in curve.

3.10.2 Oscillator

The square wave output is produced by the combination of an integrator and a hysteresis switch. The integrator converts a square wave to a triangle wave. The triangle wave causes the hysteresis switch to produce the square wave which is fed back to the integrator.

The integrator is made up of a current switch and a capacitor. The square wave applied to the current switch causes a square current signal to be applied to the capacitor.

Positive constant current produces an increasing voltage ramp on the capacitor and negative constant current produces a decreasing voltage ramp. For a square wave input, therefore, the output is a triangle wave.

Changing the magnitude of the "currents", by changing the input voltage to the module, changes the rate at which the capacitor charges and discharges to the hysteresis points thus the frequency of oscillation changes.

3.11 M30 - CRYSTAL REFERENCE

This module supplies reference frequencies at 1 kHz, 1 MHz, 2 MHz, 40 MHz and its harmonics, 1200 MHz (from 120 comb) and 1440 MHz to the phase locked loops in the instrument. These signals are produced by a 40 MHz crystal oscillator and a series of dividers and multipliers. See Figure 3-16.

3.11.1 40 MHz Oscillator

This crystal oscillator is the heart of the accuracy of the frequency determining circuits in the instrument. It is temperature compensated for frequency stability. A leveler circuit causes the oscillator output level to be the same in all M30 modules.

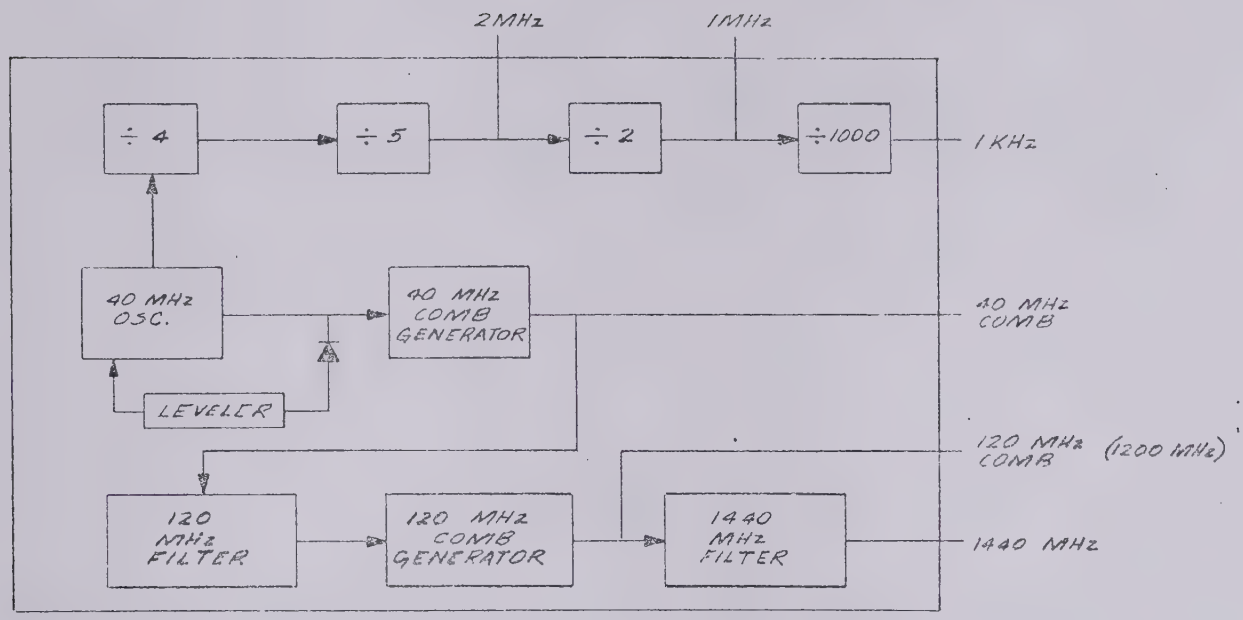



Figure 3-16. M30 - Crystal Reference

3.11.2 Dividers

The lower frequencies are produced by a series of TTL counters. A "divide by 4" followed by a "divide by 5" circuit produces the 2 MHz output. This frequency is further divided as shown in Figure 3-16 to provide the 1 MHz and 1 kHz outputs.

3.11.3 Multipliers

The 40 MHz CW is fed to a harmonic generator which produces the "comb" output.

From the 40 MHz comb, 120 MHz is selected and applied to another harmonic generator. The 120 MHz comb output is also fed to a filter which provides the 1440 MHz output.

3.12 M31 - kHz STEPS

The input to this module is the BCD data from the front panel "kHz" switches (to the right of the decimal point). The output frequency is 10 MHz - $S_k$ kHz, where $S_k$ is the number indicated by the kHz switches. If the FREQUENCY is set to 333.333 MHz, for example, the M31 output is 9.667 MHz. The block diagram of the M31 is shown in Figure 3-17.

3.12.1 VCO

The output frequency is generated by a voltage controlled oscillator which is coarsely tuned by a D/A converter and fine tuned by inclusion in a phase locked loop within the module.

3.12.2 D/A Converter

The BCD information from the switches is converted to an analog signal which biases the varactor diode in the VCO.

Each BCD line corresponds to a different current source which is switched on by a logic "1" on its BCD line. The amount

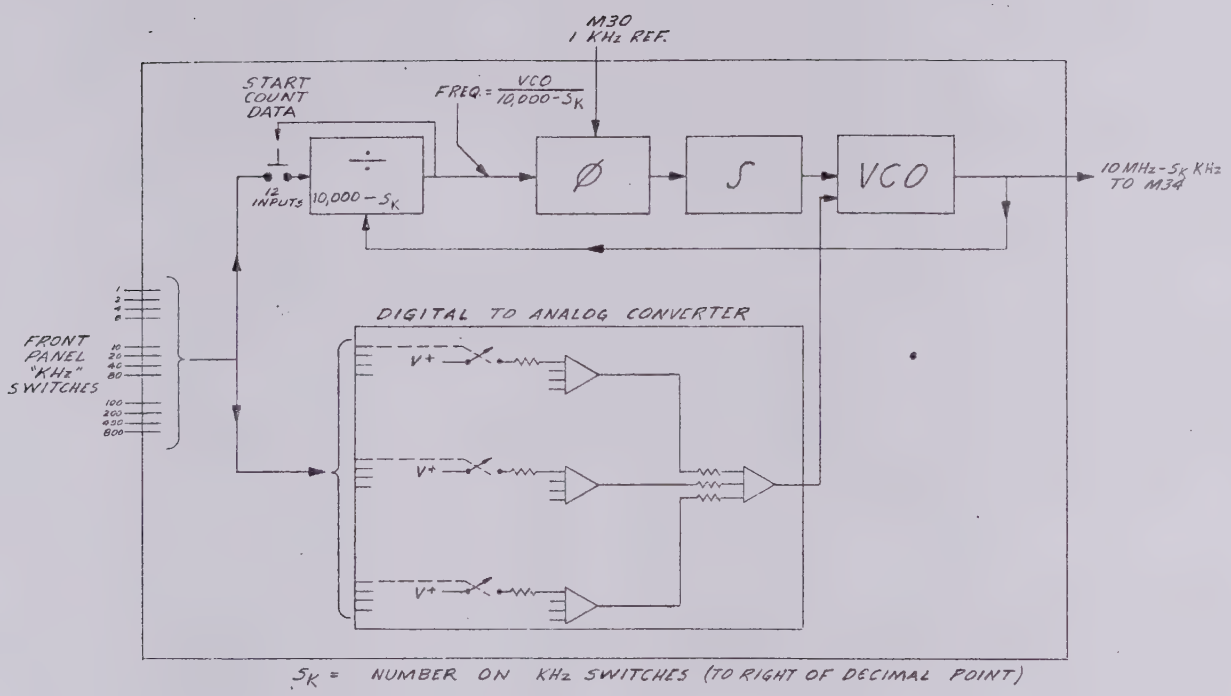



Figure 3-17. M31 - kHz Steps

of current from a source depends on the significance of its corresponding BCD line. For example, when the 4's line is activated, twice as much current is supplied as when the 2's line is activated. Summing amps add the weighted inputs and give the appropriate analog voltage output.

3.12.3 Phase Locked Loop

Including the VCO in a phase locked loop allows the accurate programmability. The fine tuning voltage comes from the phase detector and is filtered by an integrator stage. The M30 provides the 1 kHz reference to the phase detector. A sample of the VCO output is fed back to the programmable divider which feeds the lower frequency signal to the phase detector. When the loop is locked the divider output is 1 kHz.

In order for the M31 to perform properly, the divider is designed to divide the VCO frequency by $(10,000-S_k)$, where $S_k$ is the number set on the "kHz" switches. The divider counts the number of cycles at its input and puts out a pulse when the count reaches 10,000. The starting count is the number shown on the kHz switches. For example, if the instrument is set for 222.500 MHz this circuit would divide by 9,500 (count from 500 to 10,000). Therefore, the variable input to the phase detector would be correct only if the VCO put out 9.500 MHz.

3.13 M32 - MHz STEPS

The M32 provides for the M34, a reference frequency which corresponds to the setting on the "MHz" switches. See block diagram, Figure 3-18. The M32 output range is 1448 to 1487 MHz which

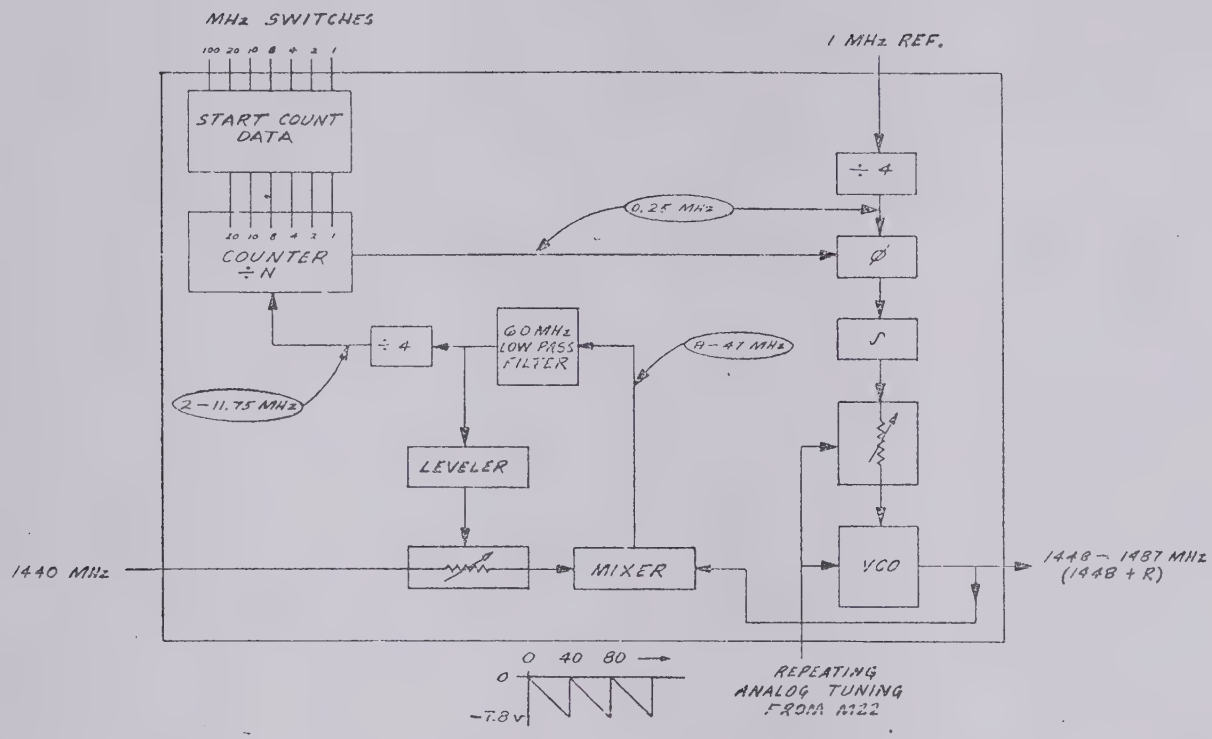



Figure 3-18. M32 - MHz Steps

repeats itself with every 40 MHz change of the frequency switches. Any specific M32 output relates to the "MHz" switch setting ($S_m$) by the equation "Output = (1448 + R) MHz", where R is the remainder of dividing $S_m$ by 40. If the front panel is set, for example, for 333.333, R would be 13.

3.13.1 VCO

The output is produced by a voltage controlled oscillator. This VCO is coarsely tuned by the repeating analog output of the M22. Fine tuning is the result of including the VCO in a phase locked loop. In addition to the VCO the phase locked loop includes a phase detector and programmable divider.

3.13.2 Phase Detector

The fixed reference frequency to the phase detector is 250 kHz. The variable input from the counter provides the error signal which represents the deviation of the VCO from the desired output. When both inputs to the phase detector are 250 kHz the loop is locked.

If the VCO output frequency is high, the variable phase detector input is high. This results in a positive output which causes a negative output from the integrator. More negative bias to the varactor increases the tuning capacitance thus lowering the VCO frequency.

A voltage controlled attenuator between the integrator and the VCO keeps the open loop gain of the phase locked loop relatively constant over the programmed frequency range. This allows the loop noise to be minimized.

3.13.3 Programmable Divider

In order for the proper VCO output frequency to produce 250 kHz to the phase detector it undergoes three conversions. It is first heterodyned with 1440 MHz yielding between 8 and 47 MHz. This frequency is then divided by four so that it will fall within the frequency range of the ÷N counter.

When the loop is locked the input to the ÷N counter will be N times 250 kHz. Changing N (by changing the MHz switches) ultimately causes the VCO to change in order for the loop to stay locked. "N" ranges from 8 to 47. In order for N to be between 8 and 47, the counter must count to 47 and start counting as determined by the "start count data". Data input is 39 for N=8 and 0 for N=47.

The "Start Count Data" circuit converts the BCD negative logic from the MHz switches into BCD positive logic according to the formula: "start count" = 39-R. (R is defined above.)

3.14 M33 - NARROW OSCILLATOR LOCK

The M33 is part of a phase locked loop for which the VCO is the "Narrow Oscillator" in the M9W. The M33 includes a phase detector, mixer and an electronic "reference" switch. See Figure 3-19.

3.14.1 Phase Detector

This circuit compares the reference frequency to the variable frequency which represents the VCO output. IF the VCO is too high, for example, the phase detector puts out a more positive voltage which is filtered and inverted by an

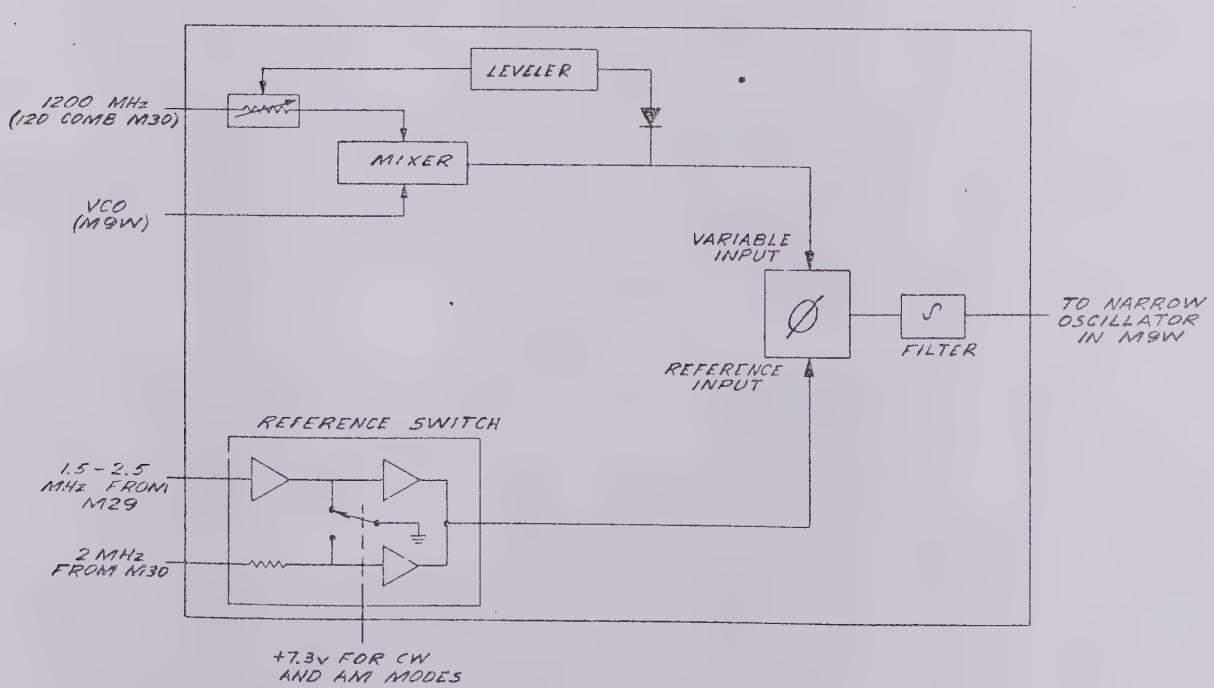



Figure 3-19. M33 - Narrow Oscillator Lock

integrator and applied to the VCO (narrow oscillator) to lower the frequency.

3.14.2 Mixer

The phase detector can not operate at UHF frequencies so the VCO is mixed with 1200 MHz CW. This provides an offset frequency which is the variable input to the phase detector. The deviation of this variable signal from 2 MHz is precisely the same as the deviation of the VCO from 1198 MHz.

3.14.3 Reference Switch

This circuit, controlled by the MODE switch on the instrument front panel, selects either the 2 MHz CW reference for CW operation or the FM reference (1.5-2.5 MHz) for FM operation of the instrument. The reference switch uses a hex inverter to electronically route the reference signals as well as to guarantee that TTL levels will be fed to the phase detector.

3.15 M34 - WIDE OSCILLATOR LOCK

This module provides the fine tuning program for the wide oscillator in the M9W. Figure 3-20 is the block diagram of the M34. The letters A thru F relate the signals at the associated points in the module to the graphs A thru F in Figures 3-18 and 3-19. The M34 phase locks the VCO to 1198 MHz plus the frequency indicated on all six front panel switches.

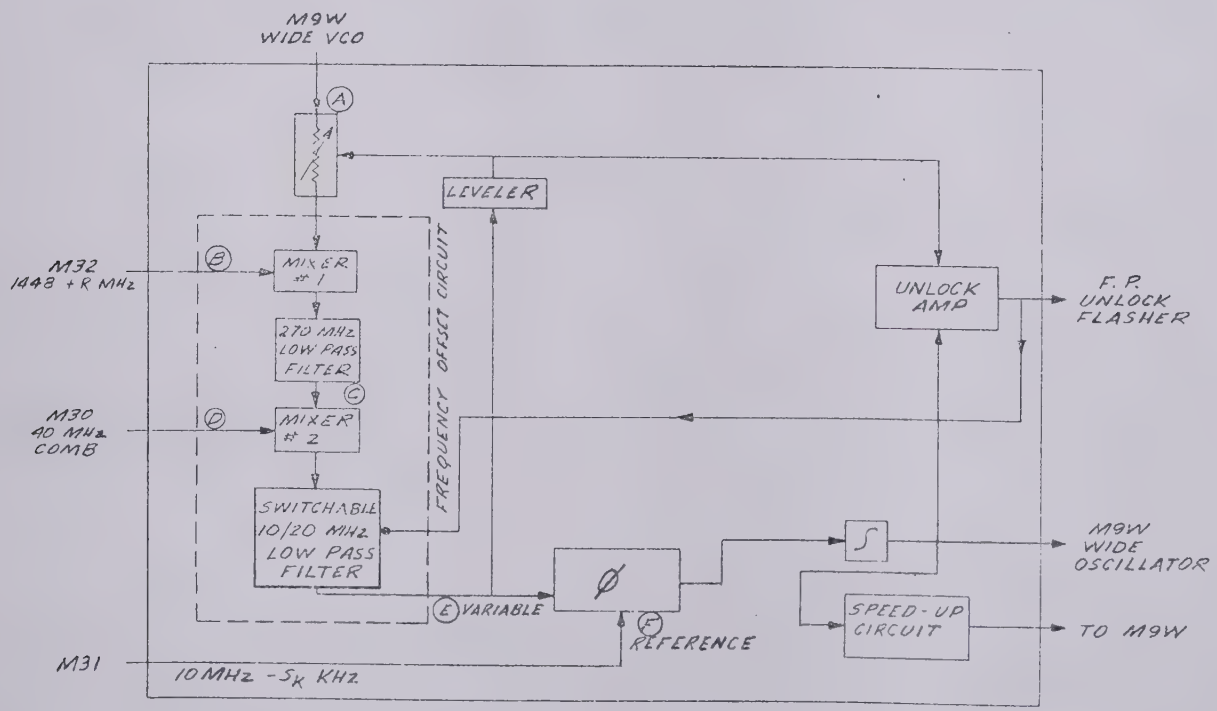



Figure 3-20. M34 - Wide Oscillator Lock

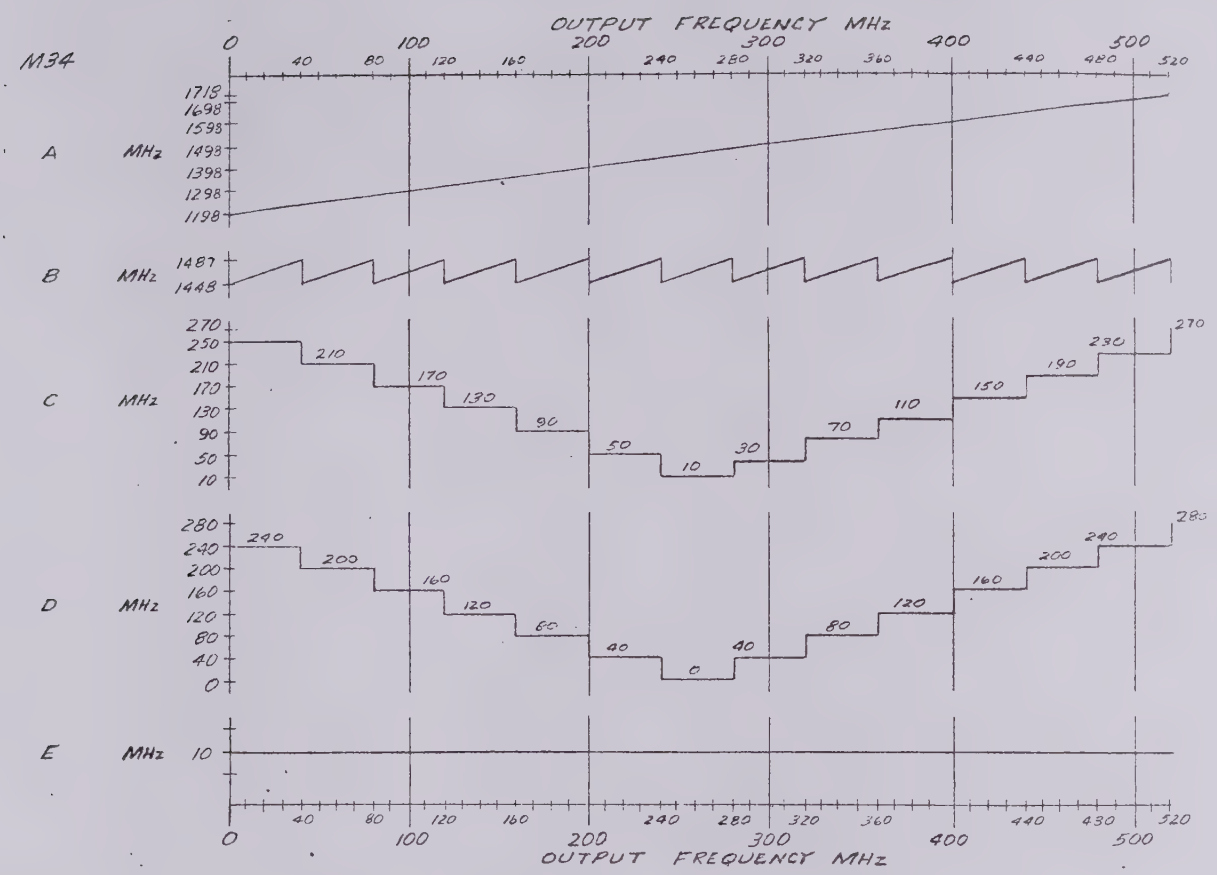



Figure 3-21. M34 - Signal Frequencies

The frequency offset circuit converts the frequency of the VCO to a lower frequency which retains the frequency error information for use by the phase detector. In addition to the frequency offset circuit and the phase detector, several auxillary circuits are included.

3.15.1 Phase Detector

The phase detector compares the "offset" VCO frequency to the reference frequency from the M31. (Refer to the description of the M31 for a more detailed description of this 10.000 - 9.001 MHz reference.)

The phase detector output voltage goes positive or negative to ultimately drive the wide oscillator higher or lower in frequency until both inputs to the phase detector are the same frequency. The integrator serves as a low pass filter for the phase detector.

3.15.2 Frequency Offset Circuit

The VCO error information must be converted to a frequency useable by the phase detector. This conversion is made by mixer #1, a 270 MHz low pass filter, mixer #2 and a 10 MHz low pass filter. Refer to Figures 3-20, 3-21 and 3-22 for descriptions of signals.

Mixer #1 heterodynes the VCO frequency with the "MHz steps" reference frequency (1448 + R) MHz. The difference frequency, $|1448 + R - VCO|$, is below 270 MHz. This signal is sent to mixer #2 where it is heterodyned with the 40 MHz comb. Graph D in Figure 3-21 shows only the comb frequency which will yield the desired output (below 20 MHz) of mixer #2. The comb actually contains all the harmonics of 40 MHz. If the loop is locked, mixer #2 will produce a 10 MHz difference as shown in Figure 3-21 (assuming the "kHz" switches are set for

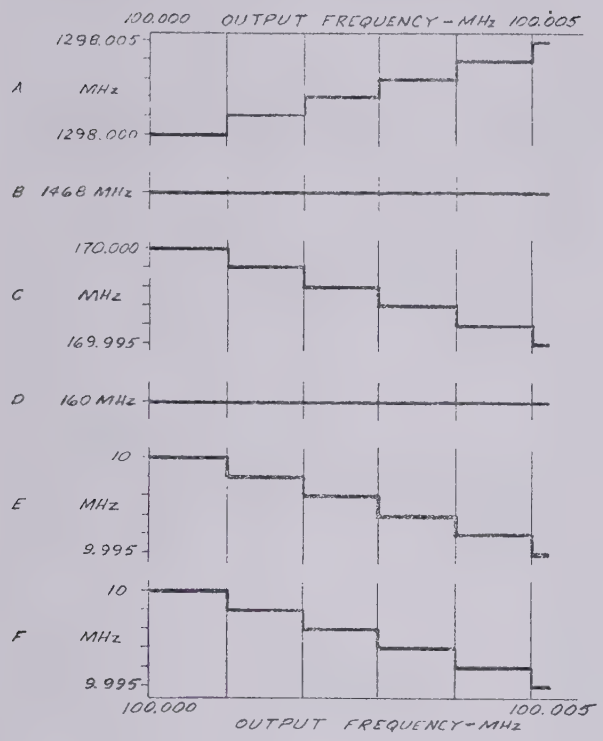



Figure 3-22. M34 - Frequencies (Expanded)

000). Figure 3-22 shows signals A thru F for a case when the kHz switches are not 000.

The filter after the mixer #2 blocks all the outputs of the mixer except the lower frequency signal containing the VCO error information. When the unit is unlocked the filter passes up to 20 MHz (to be able to capture over the 20 MHz range allowed for analog tuning). Once the loop is locked the filter decreases to 10 MHz to further eliminate phase locked loop related spurious signals.

3.15.3 Auxillary Circuits

The "speed-up circuit" is activated when the phase locked loop becomes unlocked. The output of this circuit is sent to the M9W to cause the VCO to be tuned faster by the analog voltage.

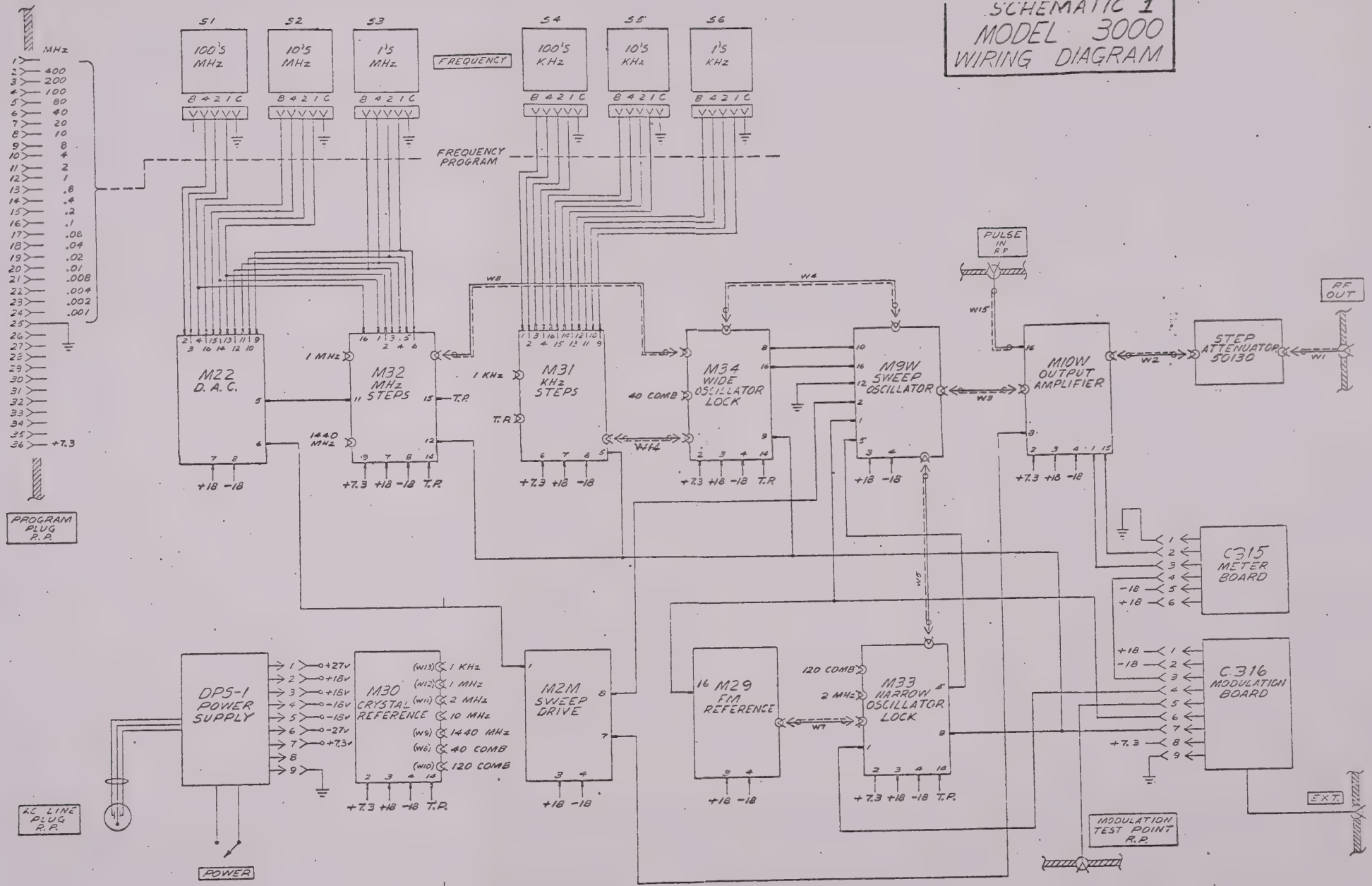
The "unlock" amp monitors both the tuning voltage from the phase detector and the leveler voltage to detect an unlocked condition of the M34. When unlock occurs, it sends a voltage to the flasher circuit.

The leveler circuit maintains a constant input amplitude to the phase detector by controlling the amplitude of the input from M9W wide oscillator. The input to the phase detector (about 10 MHz) is peak detected and compared to a DC reference in the leveler circuit. The leveler circuit controls a PIN diode attenuator which is between the VCO input and mixer #1.

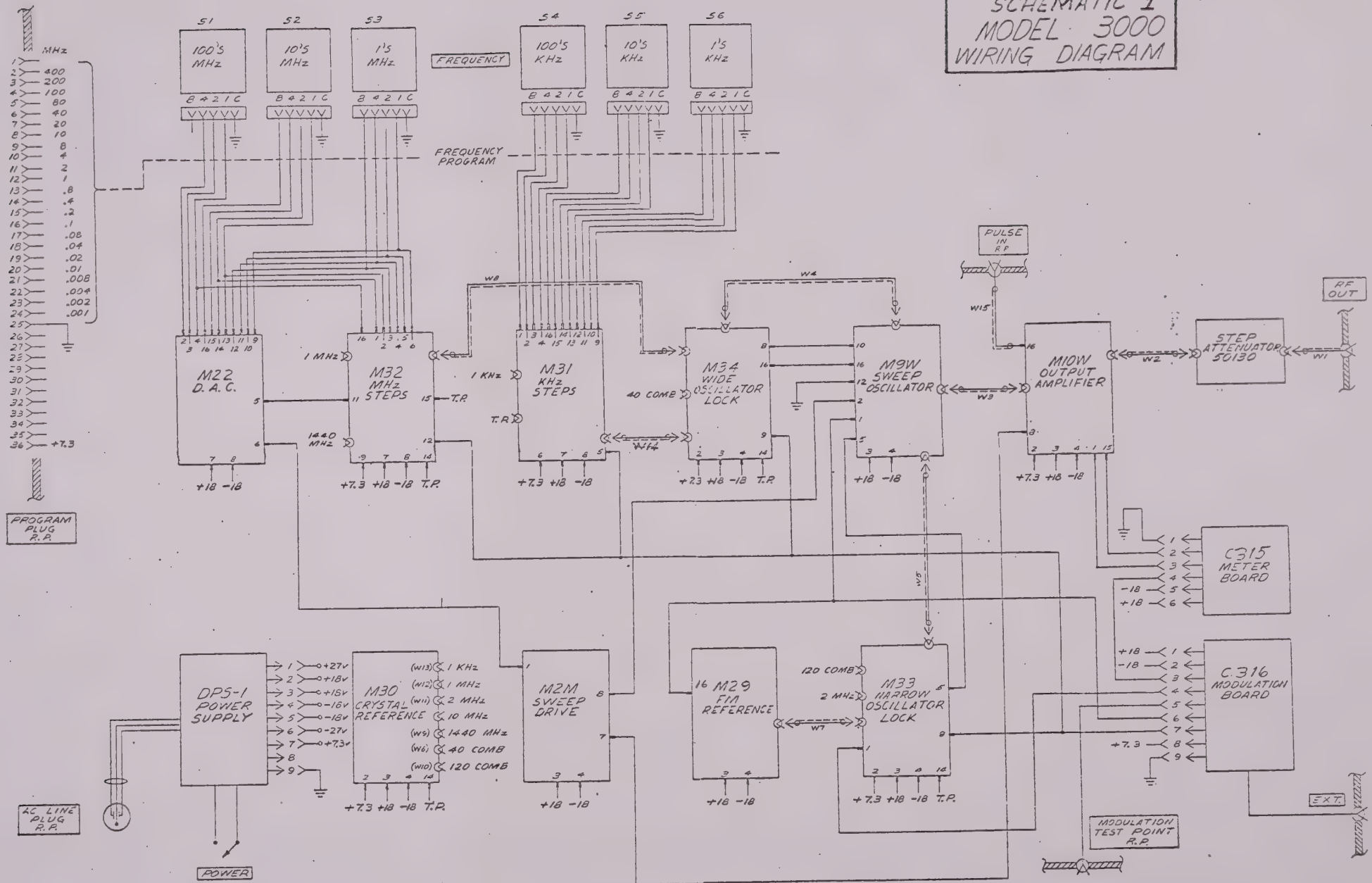
# SECTION 4
# SCHEMATICS

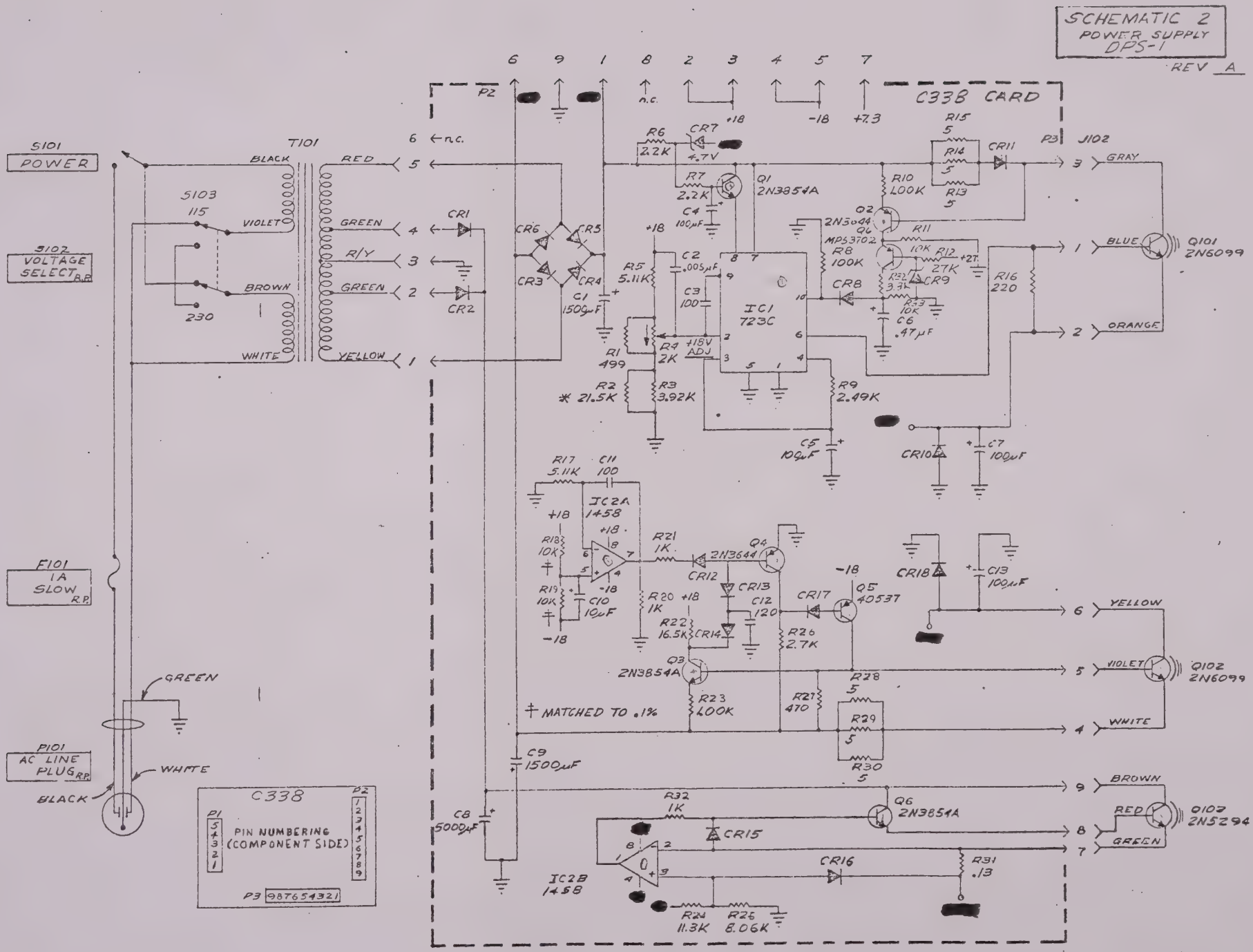
| ASSEMBLY | NAME | SCHEMATIC NO. |
|---|---|---|
| C315 | Meter Board | 13 |
| C316 | Modulation Board | 4 |
| DPS-1 | Power Supply | 2 |
| M2M | Sweep Drive | 9 |
| M9W | Sweep Oscillator | 12 |
| M10W | Output Amplifier | 14 |
| M22 | DAC | 8 |
| M29 | FM Reference | 5 |
| M30 | Crystal Reference | 3 |
| M31 | kHz Steps | 6 |
| M32 | MHz Steps | 10 |
| M33 | Narrow Oscillator Lock | 7 |
| M34 | Wide Oscillator Lock | 11 |
| Model 3000 | Wiring Diagram | 1 |

# SCHEMATIC 1
# MODEL 3000
# WIRING DIAGRAM



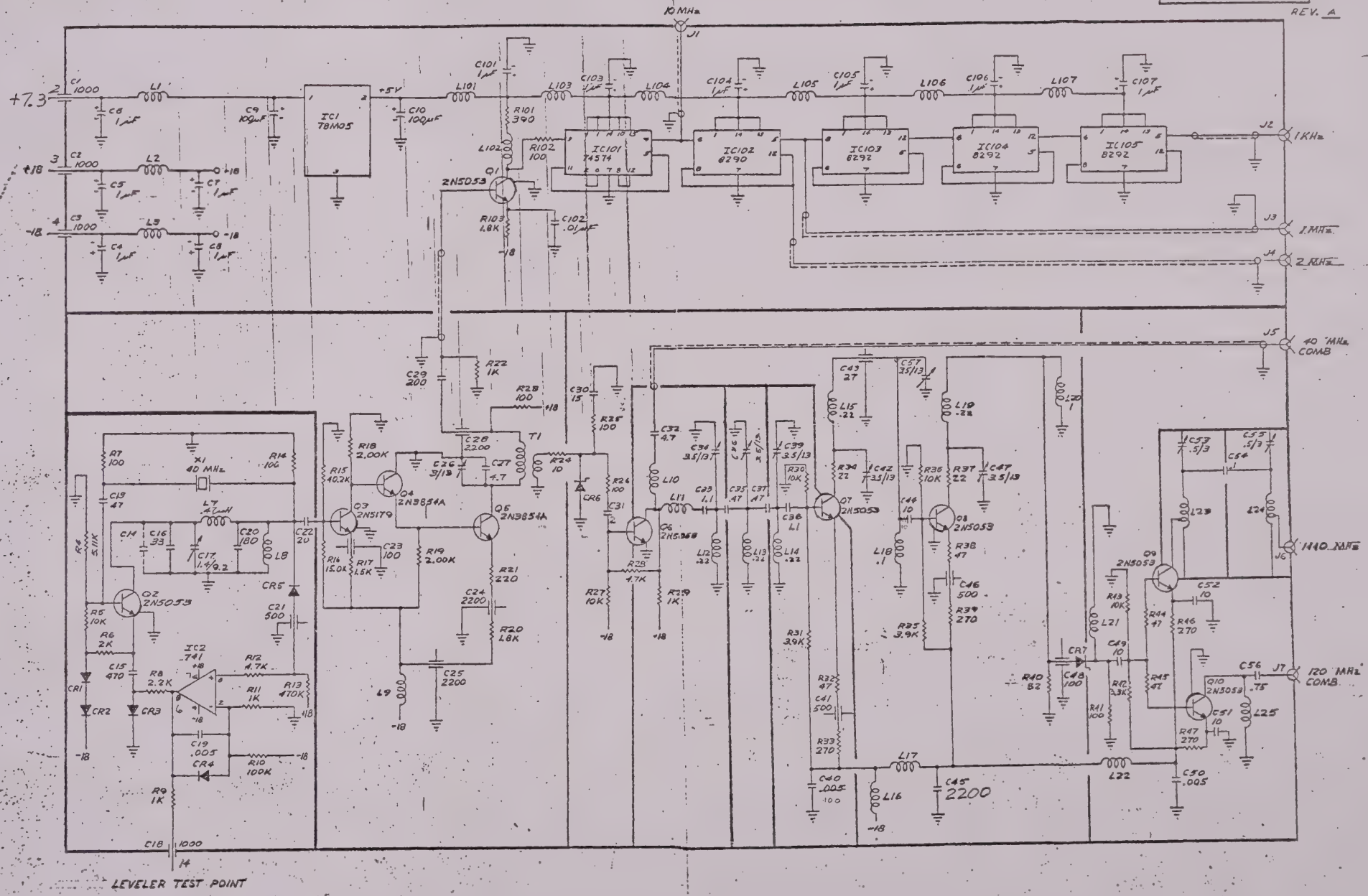
# SCHEMATIC 1
# MODEL 3000
# WIRING DIAGRAM



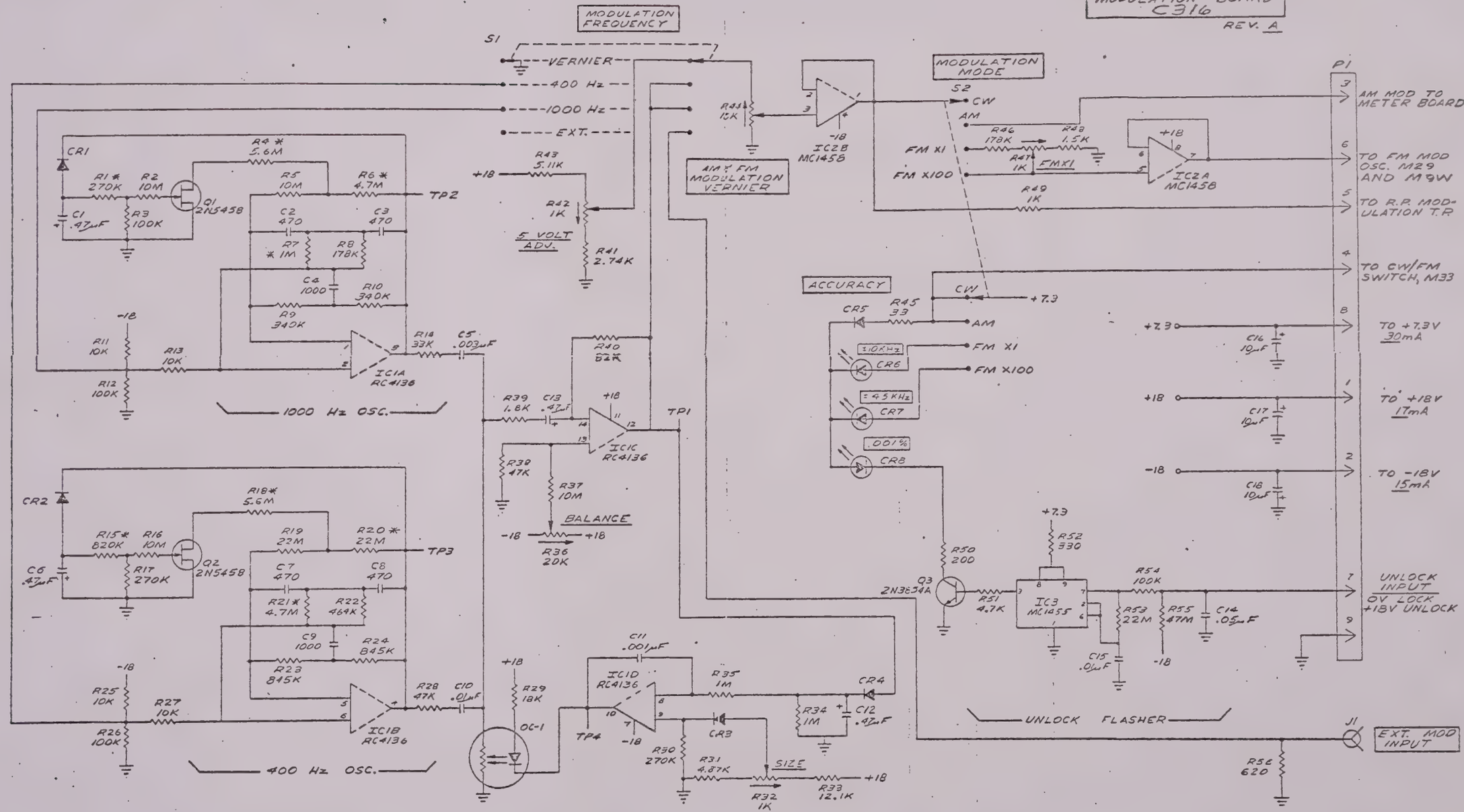

SCHEMATIC 2
POWER SUPPLY
OPS-1
REV A
C338B CARD
P2
6 9 1 8 2 3 4 5 7
n.c. +18 -18 +7.3
S101 POWER
S102 VOLTAGE SELECT R.P.
S103 115
230
T101
BLACK
VIOLET
BROWN
WHITE
RED
GREEN
R/Y
GREEN
YELLOW
F101 1A SLOW R.P.
P101 AC LINE PLUG R.P.
GREEN
WHITE
BLACK
C338
P1
P2
PIN NUMBERING (COMPONENT SIDE)
P3 987654321
CR1
CR2
CR3
CR4
CR5
CR6
R1 499
R2 * 21.5K
R3 3.92K
R4 2K +15V ADJ
R5 5.11K
C1 1500µF
C2 .005µF
C3 100
IC1 723C
R6 2.2K
CR7 4.7V
R7 2.2K
C4 100µF
Q1 2N3854A
R8 100K
Q2 2N3644
Q4 MPS3702
R9 2.49K
R10 100K
R11 10K
R12 27K +27
R32 3.3K
CR9
R33 10K
C6 .47µF
CR8
R14 5
R15 5
R13 5
CR11
R16 220
C5 100µF
CR10
C7 100µF
P3 J102
3 GRAY
1 BLUE
2 ORANGE
Q101 2N6099
R17 5.11K
C11 100
IC2A 1458
R18 10K
R19 10K
C10 10µF
R21 1K
Q4 2N3644
CR12
CR13
R20 1K
C12 120
R22 16.5K
CR14
CR17
Q5 40537
R26 2.7K
CR18
C13 100µF
6 YELLOW
Q3 2N3854A
R23 100K
R27 470
R28 5
R29 5
R30 5
5 VIOLET
4 WHITE
Q102 2N6099
† MATCHED TO .1%
C9 1500µF
C8 5000µF
R32 1K
Q6 2N3854A
CR15
CR16
R31 .13
IC2B 1458
R24 11.3K
R25 8.06K
9 BROWN
8 RED
7 GREEN
Q107 2N5294

SCHEMATIC 3
CRYSTAL REFERENCE
M30

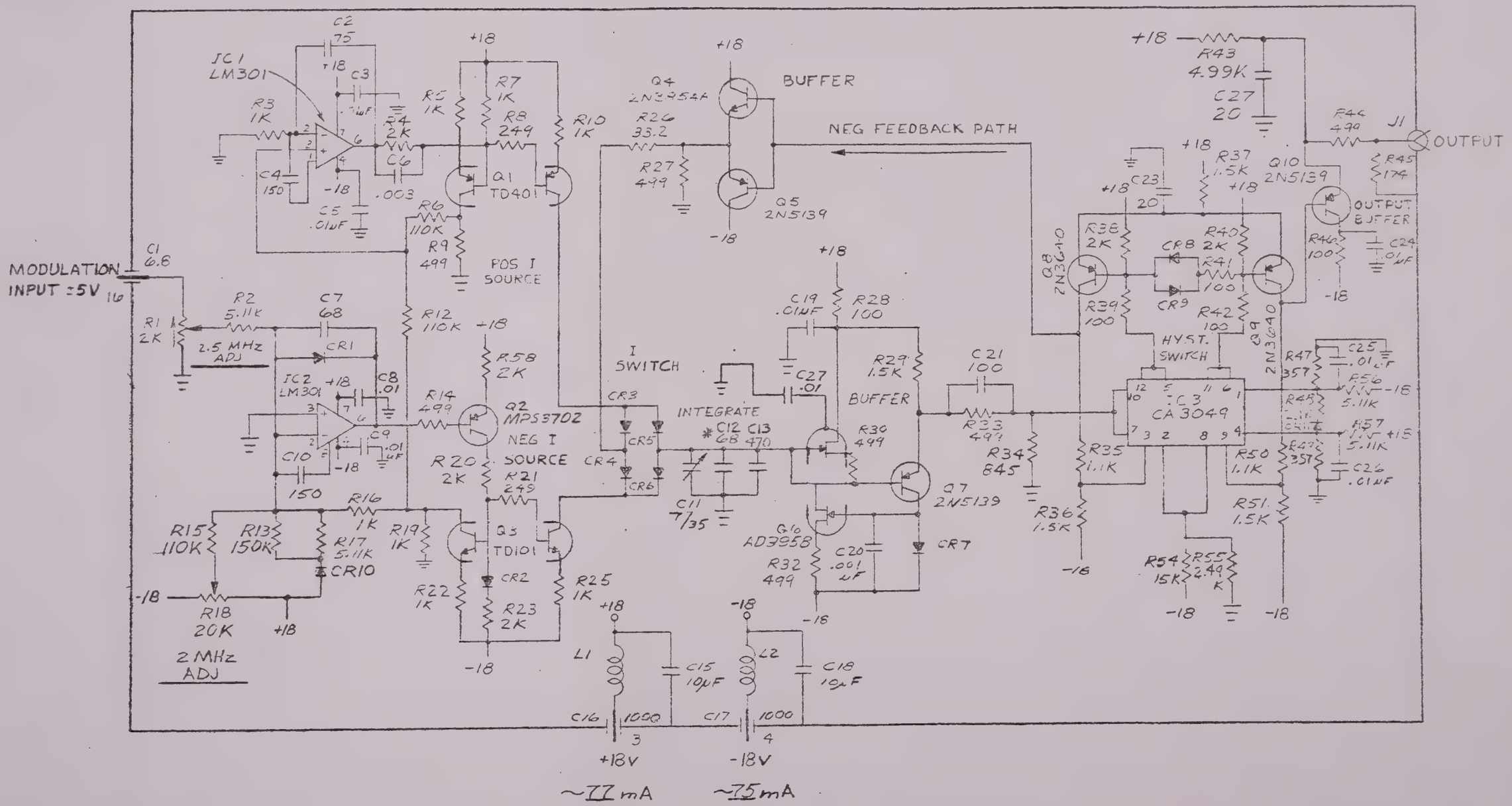
REV. A

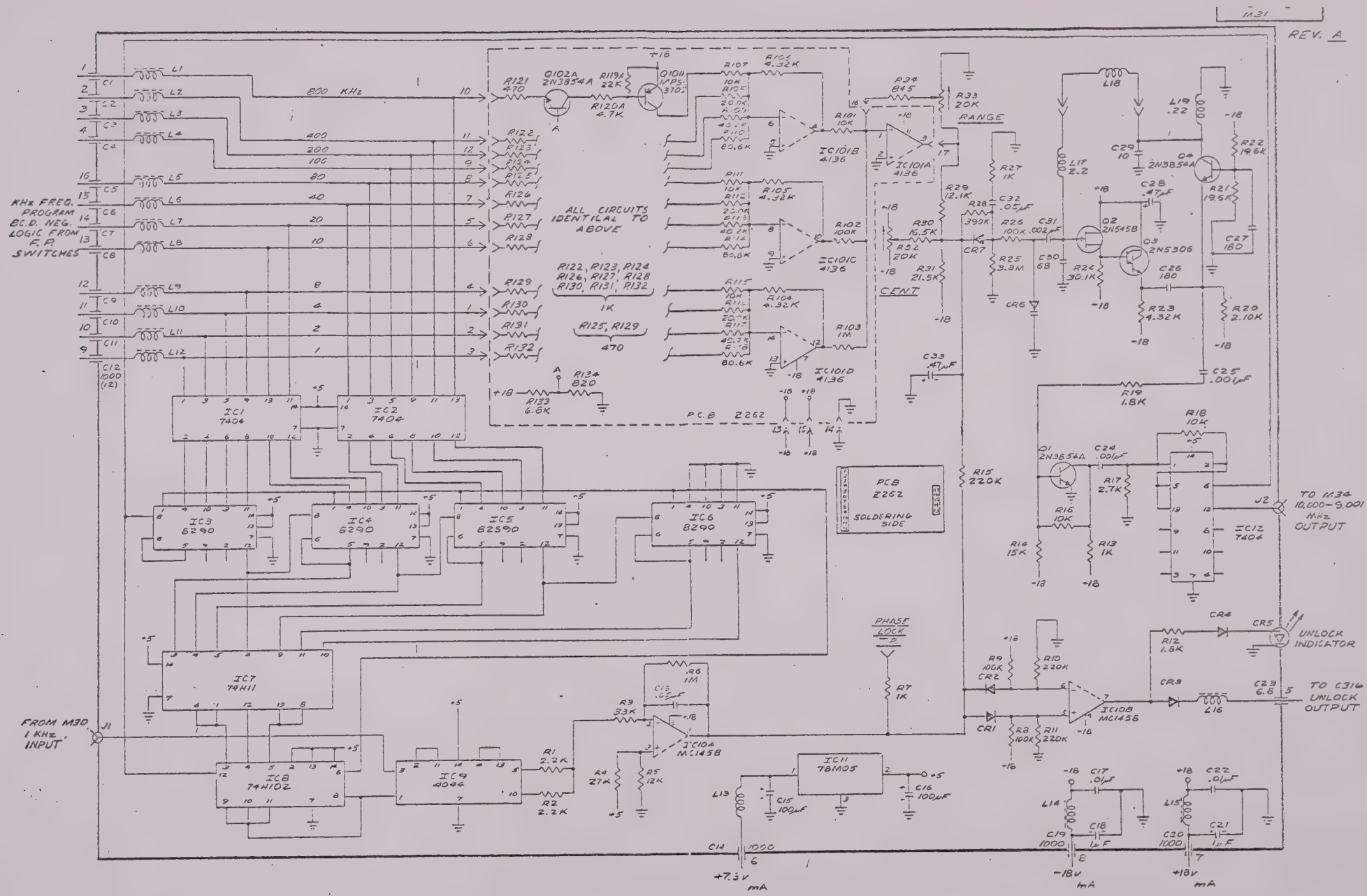


SCHEMATIC 4
MODULATION BOARD
C316
REV. A



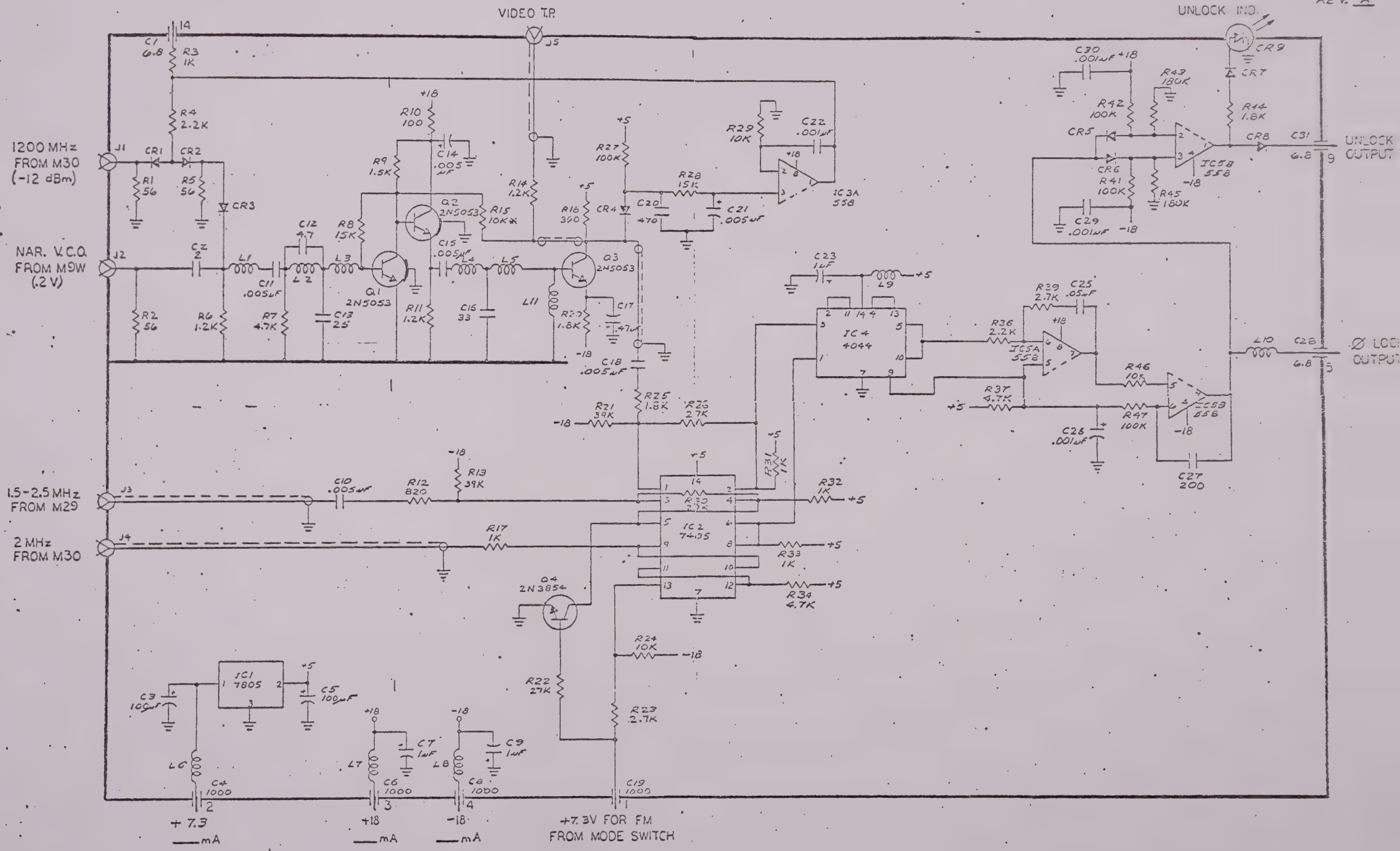
M29
FM REFERENCE
REV B

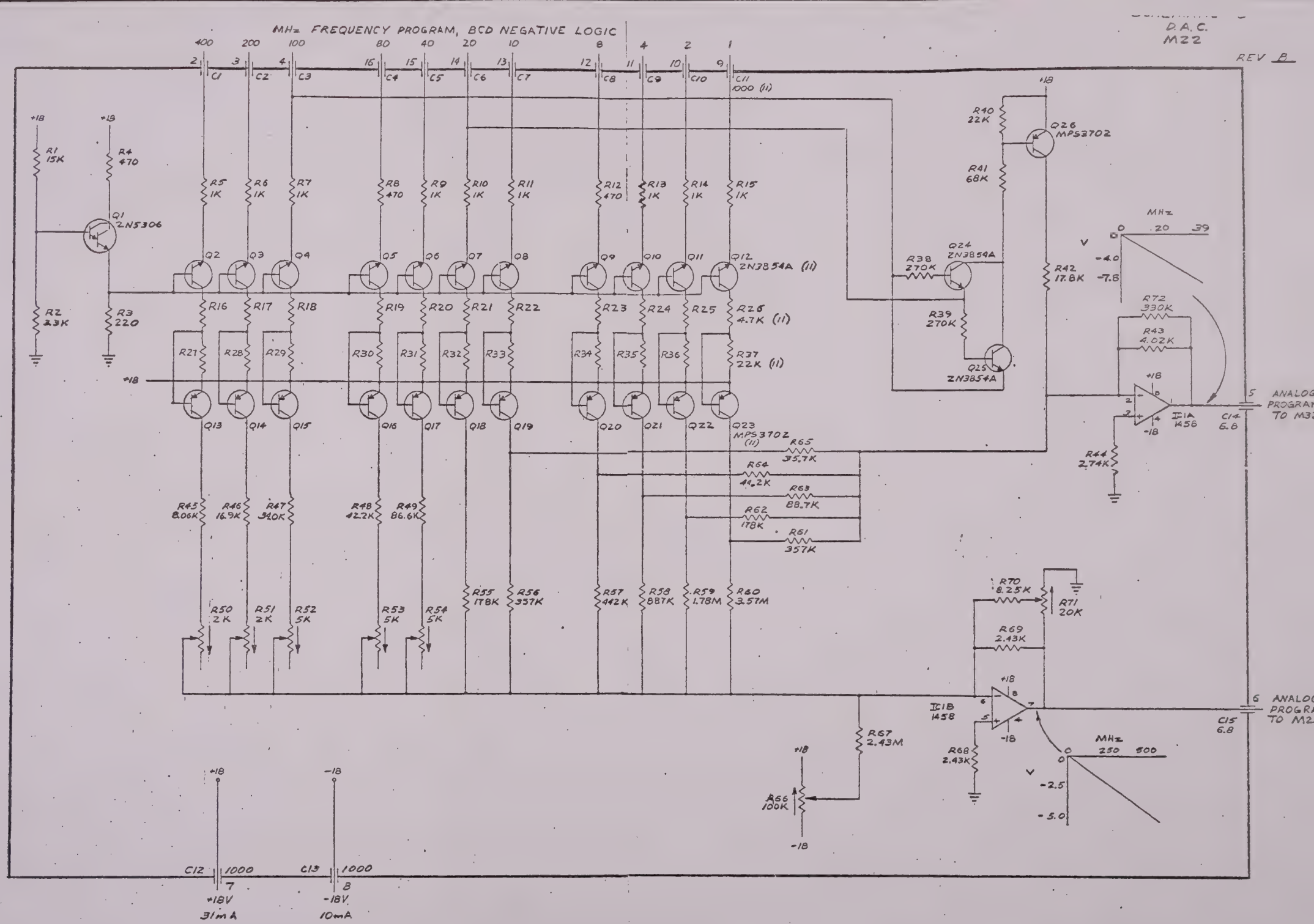



M31
REV. A
KHz FREQ. PROGRAM BC.D. NEG. LOGIC FROM F.P. SWITCHES
800 KHz
400
200
100
80
40
20
10
8
4
2
1
ALL CIRCUITS IDENTICAL TO ABOVE
R122, R123, R124 R126, R127, R128 R130, R131, R132
1K
R125, R129
470
RANGE
CENT
PCB Z262
SOLDERING SIDE
IC1 7404
IC2 7404
IC3 6290
IC4 6290
IC5 62590
IC6 8290
IC7 74H11
IC8 74H102
IC9 4044
IC10A MC1458
IC10B MC1458
IC11 78M05
IC101A 4136
IC101B 4136
IC101C 4136
IC101D 4136
IC12 7404
FROM M30 1 KHz INPUT
J1
J2
TO M34 10,000-9,001 MHz OUTPUT
PHASE LOCK
UNLOCK INDICATOR
TO C316 UNLOCK OUTPUT
+7.3V mA
-18V mA
+18V mA

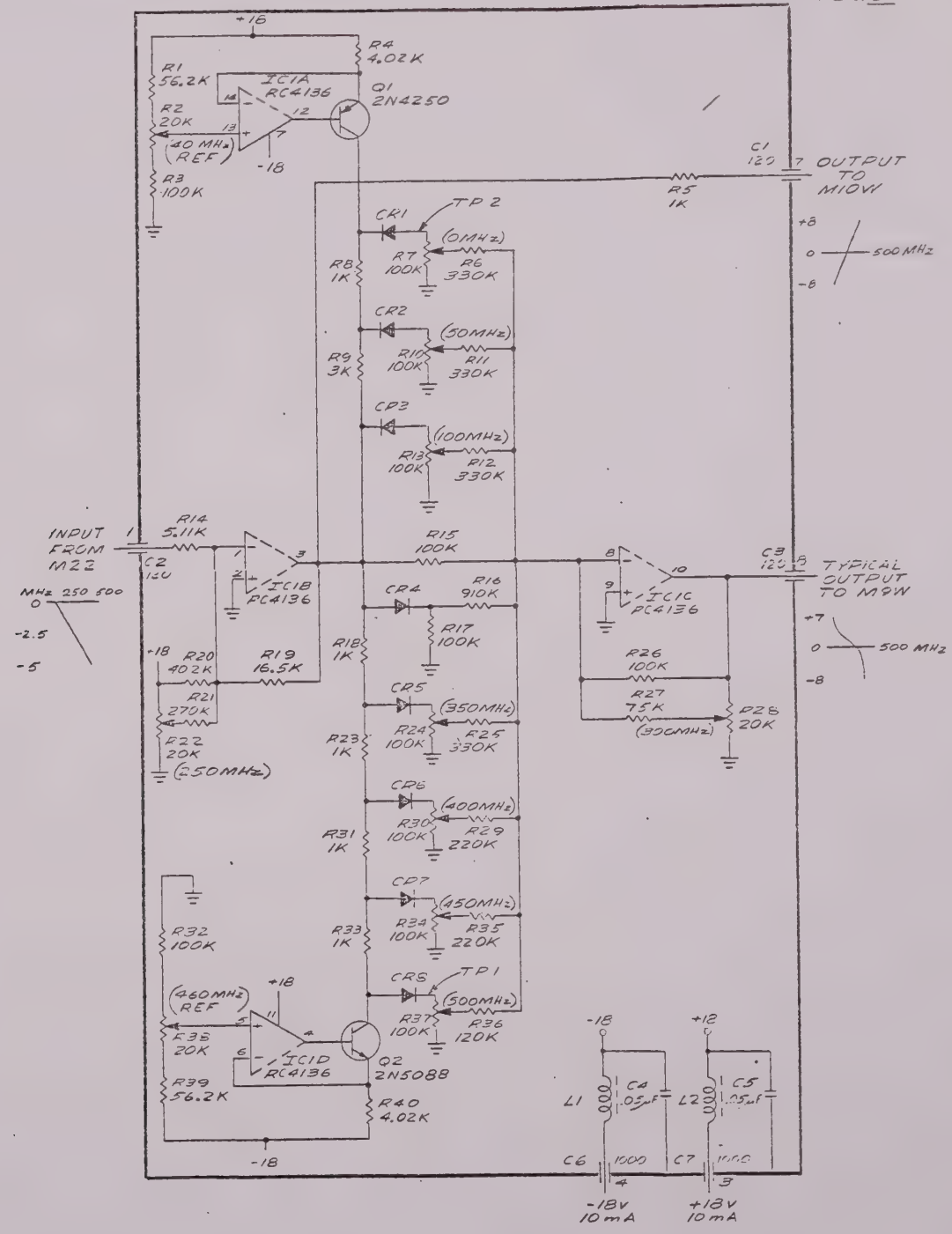
# SCHEMATIC 7
# NARROW OSCILLATOR LOCK
# M33

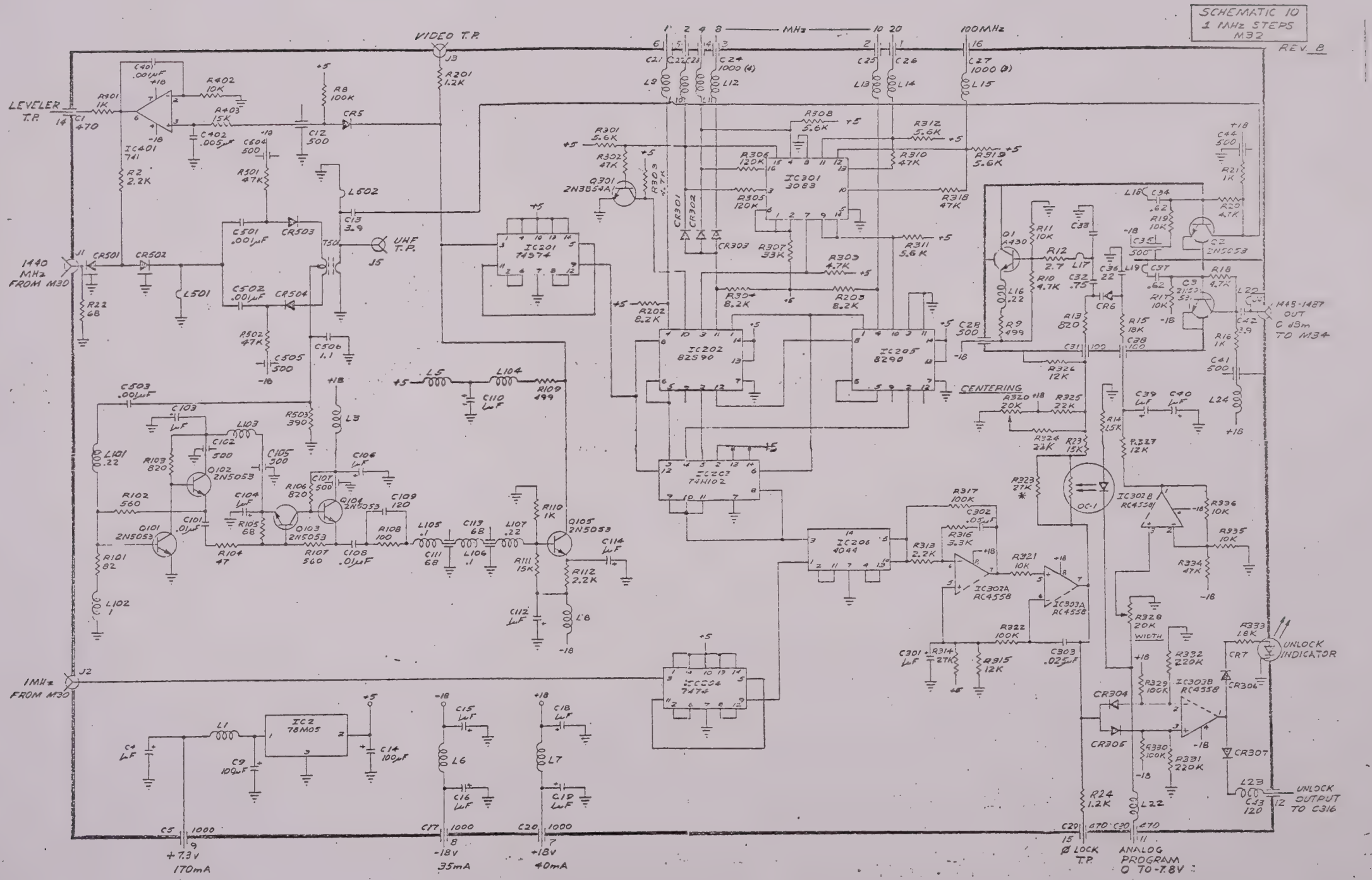
REV. A

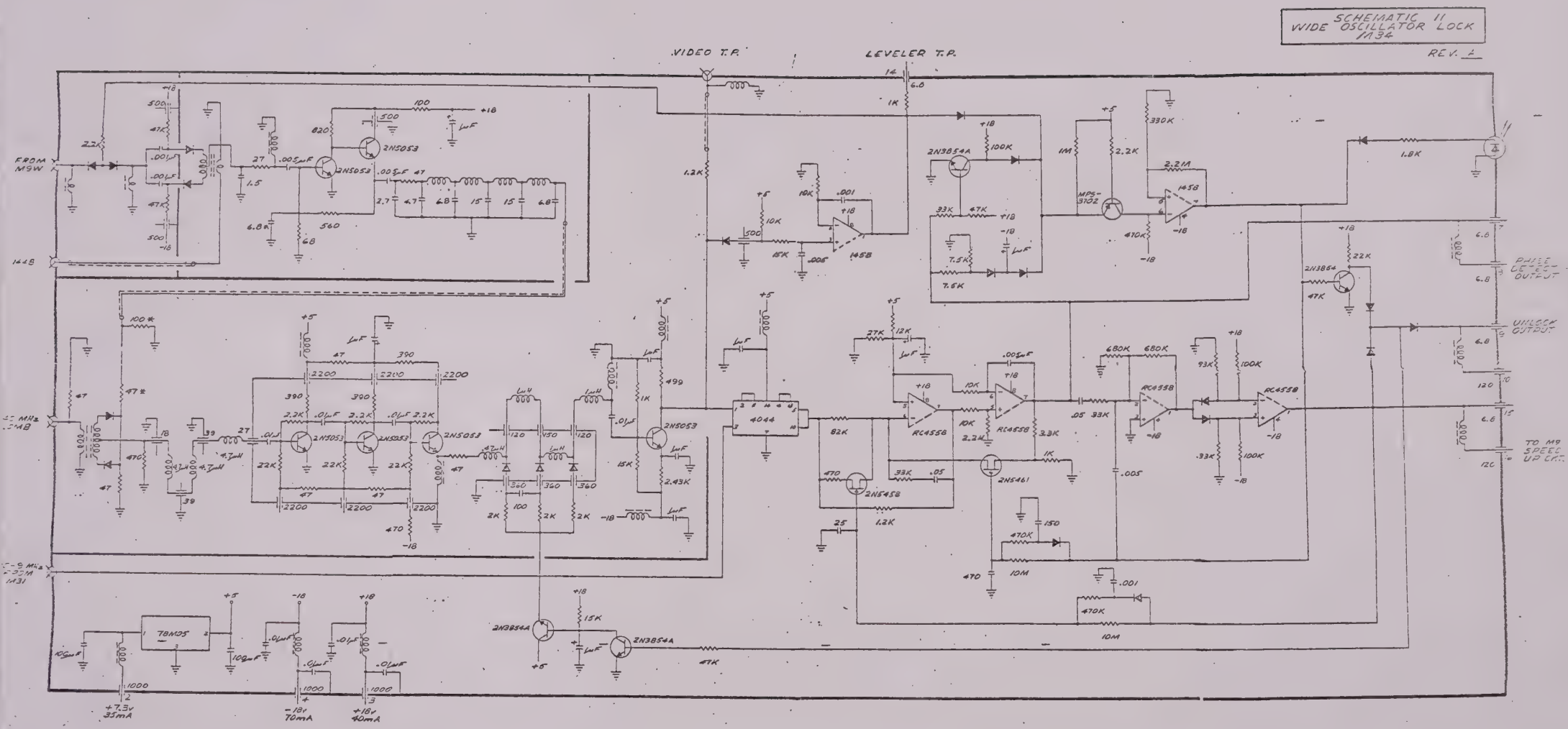



MHz FREQUENCY PROGRAM, BCD NEGATIVE LOGIC
D.A.C.
M22
REV B
400 200 100 80 40 20 10 8 4 2 1
C1 C2 C3 C4 C5 C6 C7 C8 C9 C10 C11 1000 (11)
R1 15K
R4 470
R2 2.3K
R3 220
Q1 2N5306
R5 1K R6 1K R7 1K R8 470 R9 1K R10 1K R11 1K R12 470 R13 1K R14 1K R15 1K
Q2 Q3 Q4 Q5 Q6 Q7 Q8 Q9 Q10 Q11 Q12 2N3854A (11)
R16 R17 R18 R19 R20 R21 R22 R23 R24 R25 R26 4.7K (11)
R27 R28 R29 R30 R31 R32 R33 R34 R35 R36 R37 22K (11)
Q13 Q14 Q15 Q16 Q17 Q18 Q19 Q20 Q21 Q22 Q23 MPS3702 (11)
R45 8.06K R46 16.9K R47 34.0K R48 42.2K R49 86.6K
R50 2K R51 2K R52 5K R53 5K R54 5K
R55 178K R56 357K R57 442K R58 887K R59 1.78M R60 3.57M
R65 35.7K R64 44.2K R63 88.7K R62 178K R61 357K
R40 22K Q26 MPS3702 R41 68K
R38 270K Q24 2N3854A R39 270K Q25 2N3854A R42 17.8K
MHz 0 20 39 V -4.0 -7.8
R72 330K R43 4.02K R44 2.74K
IC1A 1458
C14 6.8
5 ANALOG PROGRAM TO M32
R70 8.25K R71 20K R69 2.43K
IC1B 1458
C15 6.8
6 ANALOG PROGRAM TO M2M
R68 2.43K
MHz 0 250 500 V -2.5 -5.0
R67 2.43M
R66 100K
C12 1000 7 +18V 31mA
C13 1000 8 -18V 10mA

SCHEMATIC 3
SWEEP DRIVE
M2M
REV. B

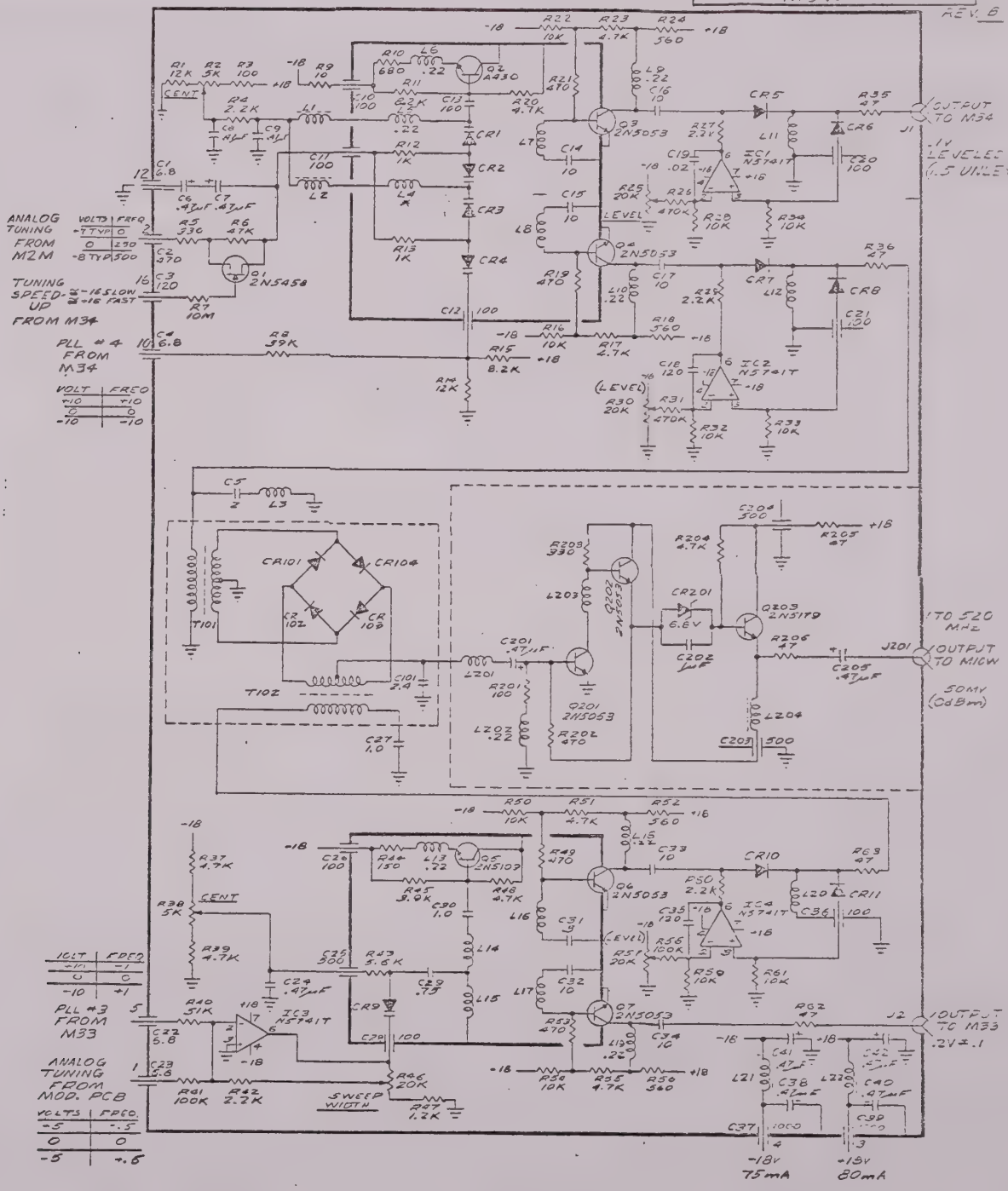



SCHEMATIC 10
1 MHz STEPS
M32
REV. B
VIDEO T.P.
LEVELER T.P.
1440 MHz FROM M30
1 MHz FROM M30
UHF T.P.
1 2 4 8 MHz 10 20 100MHz
IC401 741
IC201 74S74
IC202 82S90
IC205 8290
IC206 4044
IC203 74H102
IC204 74174
IC301 3083
IC302A RC4558
IC303A RC4558
IC303B RC4558
IC2 78M05
Q301 2N3854A
Q101 2N5053
Q102 2N5053
Q103 2N5053
Q104 2N5053
Q105 2N5053
Q1 2N5179
Q2 2N5053
OC-1
CENTERING
1448-1487 OUT 0 dBm TO M34
UNLOCK INDICATOR
UNLOCK OUTPUT TO C316
Ø LOCK T.P.
ANALOG PROGRAM 0 TO -7.8V
+7.3V 170mA
-18V 35mA
+18V 40mA

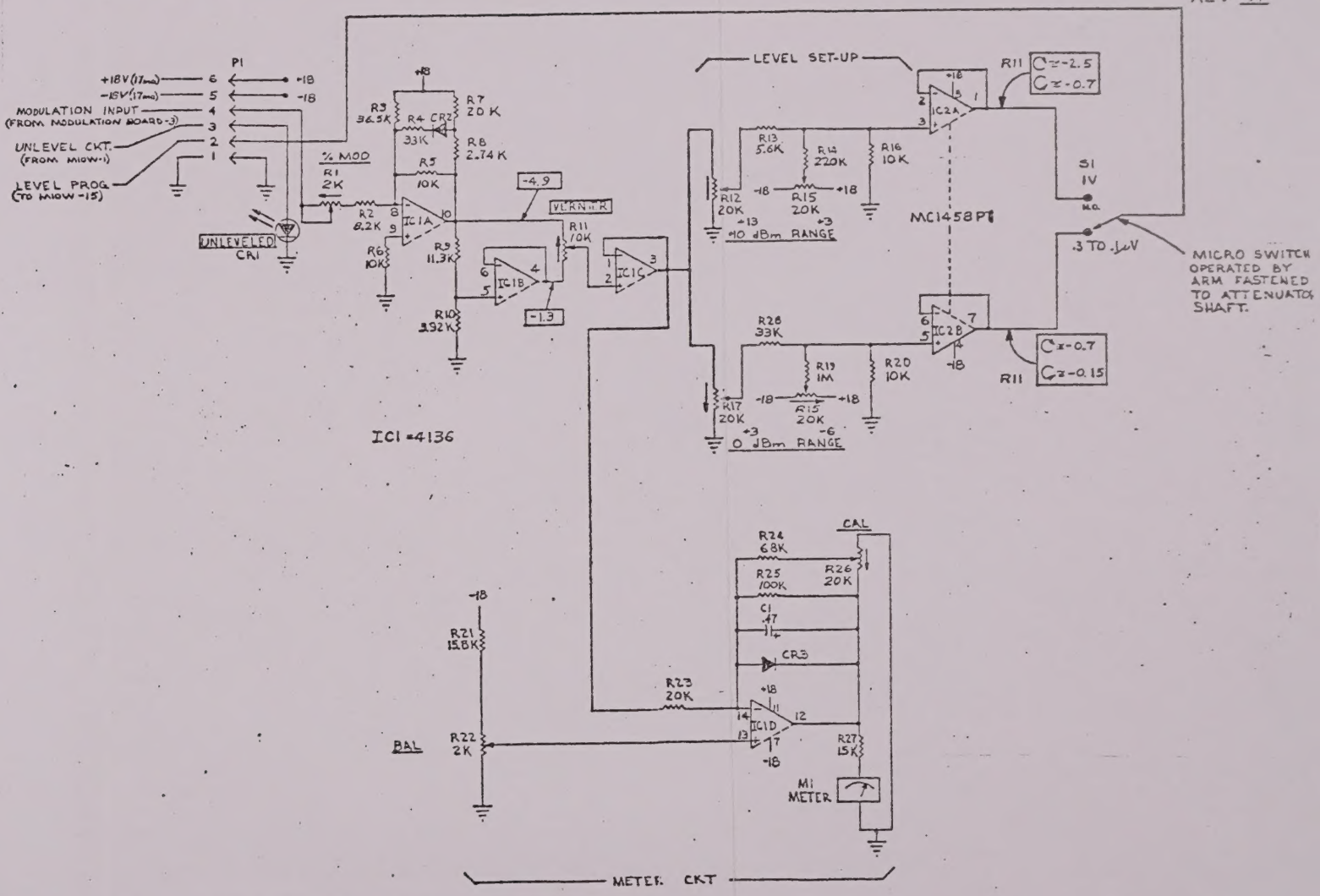

SCHEMATIC 11
WIDE OSCILLATOR LOCK
1134
REV. A
VIDEO T.P.
LEVELER T.P.
FROM MSW
1448
4044
2N5053
2N3854A
2N5458
2N5461
RC4558
MPS-3702
1458
TO M9 SPEED UP CH.
+7.3V 35mA
-18V 70mA
+18V 40mA

SCHEMATIC 12
WIDE SWEEP OSCILLATOR
1198 TO 1718 MHz
M9W

REV. B



SCHEMATIC 13
METER BOARD
C315
REV A



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